Power and The Engineer

Vol. 32 NEW YORK, JUNE 14, 1910 No. 24

MUCH has been written and said about the ridiculously low wages paid to operating engineers. When the responsibilities attendant upon the engineer's position are compared with those of other callings, the disproportionate remuneration becomes more apparent.

It would seem that an employer, being a business man, would appreciate the fact that the best is always the cheapest, and would pay a wage that would secure the highest grade of skill.

On the principle that all "coons" look alike, he grudgingly pays his engineer laborer's wages, and unless forced to do so, would pay no more for the highest grade of skill obtainable.

Some two years ago an engineer was induced to go to a Southern power plant on a wage of one hundred dollars a month, with the understanding that his future rating would depend upon his value to the plant.

With the double incentive of a possible increase in salary and the opportunity to make a record he started on a hunt for leaks.

Flange and thread joints were made steam tight. Bare piping and boiler shells were covered. Pumps and condensers were overhauled. Boilers were cleaned and the brickwork put in first class shape. Every point where heat could leak out or cold air could leak in was fortified.

In the daily operation of the plant the strictest watch was kept. Two engines were never run when one would carry the load, and in the boiler room the same rule was put into effect.

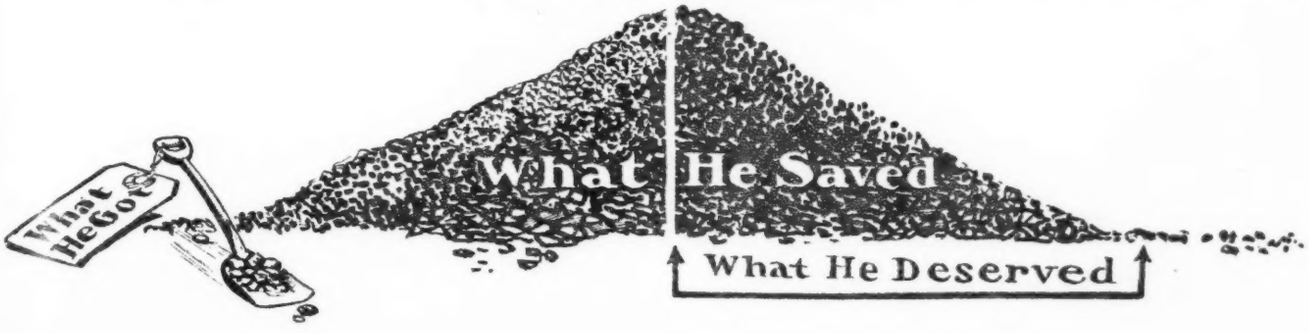
In two months the records were compared and it was found that nearly nine hundred tons of coal were being saved each month.

The chief was congratulated on his skill as an engineer, thanked for the saving he had made and offered an increase in salary of ten dollars per month.

Is it any wonder that, discouraged and disappointed, he indignantly tendered his resignation?

At a reasonable salary from the start he would have made an equally good showing. His pride in his work would compel him to do his best. But having started at half a salary with the expectation of getting a whole one in the near future, the offer of less than one per cent. of the saving effected was little if anything short of an insult.

He had saved a thousand tons of coal and was offered an advance equal the price of six.



A Small Modern Lighting Plant

By Warren O. Rogers

The plant is equipped with two noncondensing, high-speed engines, as the exhaust steam is used for heating. A storage-battery and a reserve motor-generator set taking current from the city mains insure continuity of service. A small refrigerating plant is installed.

The Osborn Memorial Home, for old ladies, is located at Harrison, N. Y. The building is set on a commanding position on the brow of a hill, where it is exposed to the coldest blasts of winter. The building contains 100 rooms, is 300 feet long, 70 feet wide and is built with four stories and a basement. It is of brick construction with ornamental marble trimmings.

Steam heat is delivered to the home from the power house, which is located 1300 feet distant, at the base of the hill. There are 1500 direct-current incandescent lamps on a 220-volt circuit, most of the lamps being of 16 and 8 candle-power capacity. The motors used for various purposes throughout the building total up to 115 horsepower, driving an elevator, air compressor, fans and a vacuum cleaner. The exhaust steam passes through a 10-inch main from the power plant, and the condensation returns by gravity to a receiver through a 3-inch return pipe, and is used again in the boilers. On extremely cold days during the winter months an average of 1400 gallons of condensed steam is returned, while the average for ordinary weather is 900 gallons. The boiler and engine house is a one-story red brick building, with a slanting slate roof.

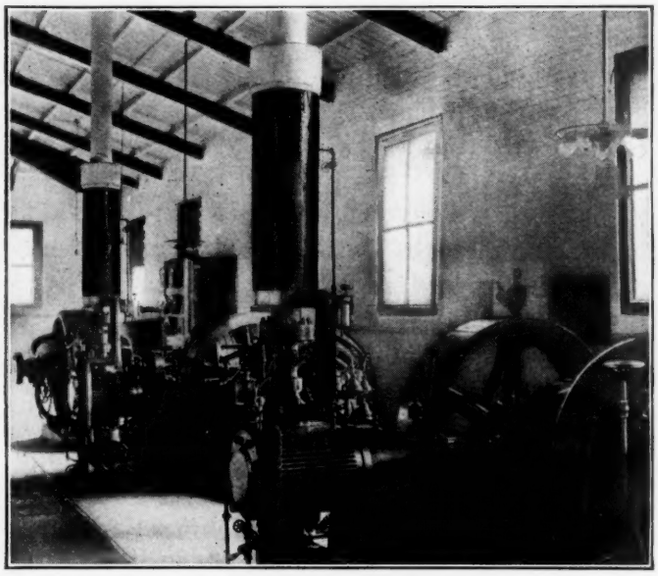


FIG. 1. HIGH-SPEED GENERATING UNITS

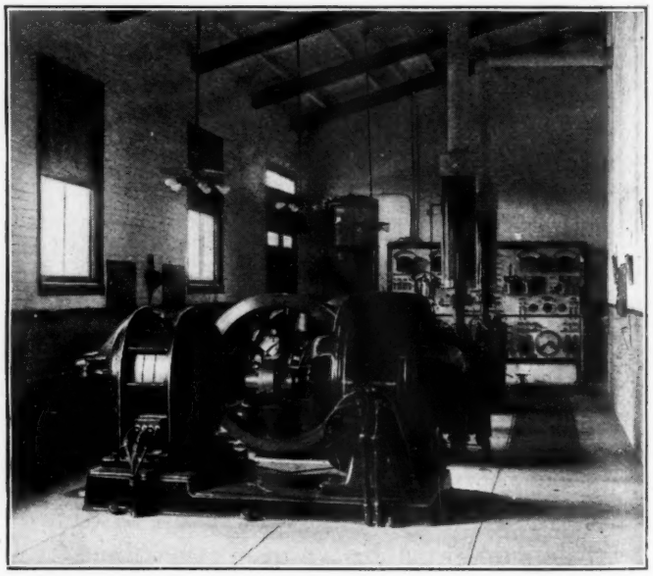


FIG. 2. MOTOR-GENERATOR SET

THE ENGINES

As the visitor steps into the building he is ushered into the oblong engine room, shown in Figs. 1 and 2. Here are found two 50-horsepower, 10x10-inch Ames high-speed engines, each direct connected to a Sprague 25-kilowatt direct-current generator, which runs at a speed of 300 revolutions per minute. Fig. 2 shows a view of the engine room from the opposite end, and a near view of the emergency unit, which consists of a 100-horsepower Stanley two-phase, 50-cycle 220-volt induction motor, direct coupled to a Sprague 60-kilowatt, 250-volt direct-current generator, which is driven at a speed of 700 revolutions per minute.

One engine is sufficient to serve all ordinary demands made upon the plant, but is supplemented by a duplicate unit and a storage-battery system, which, with the motor-driven unit for use in case both steam-driven units are inoperative, makes a complete shutdown practically impossible. In case of the steam plant becoming disabled, current is taken from the lines of the local electric-light company.

In a separate room at the rear of the switchboard is located the storage-battery cells, of the Electric Storage Company's make. There are 140 cells, each of 2.8-volts capacity. The cells are arranged on framework in tiers of three, one above the other, and are so connected that they can be cut in or out of service by means of 40 end-cell contacts, arranged on the face of the switchboard which is located at one end of the engine room, as shown in Fig. 2. As the voltage falls the end cells can be cut in one by one as needed.

At first thought one might conclude that a storage-battery installation was out of keeping with the size and demand of the plant, but such is not the case. Its use insures an increased reliability of service, as it is always ready to fill any sudden demands for current, or to carry the entire load, for a time, should the steam generating units be disabled; and more than this, it furnishes all the current during the hours of lightest load, when the engines are shut down, which, in this instance, is the greater part of the time. One engine runs from 5:30 a.m. to 7:00 a.m. and from 6:00 p.m. to 8:30 p.m. each week day, but on Sunday one engine is run from 6:00 a.m. to 12:00 noon, in order to get a slight overcharge on the storage battery.

OPERATING DETAILS

It is not so much the equipment that permits of economical operation, as the manner in which the engineer, J. B. Dickerson, handles the plant and makes every move count. For instance, when the engine is started up in the morning it furnishes current for operating a motor-driven 25-horsepower Ingersoll-Sergeant air compressor, which furnishes air for lifting water from a 500-foot drilled well at a rate of 30,000 gallons in 10 hours, but as only 10,000 to 12,000 gallons per 24 hours are required for house purposes, the compressor is operated but a small portion of the time.

During the morning run current from the generator is turned on to charge the batteries, the gravity never being allowed to get below 11.70. Although charging storage batteries daily is not the general practice with many engineers, these cells are charged each day in the year and are in perfect condition. By the time the engine is shut down after the morning and evening runs, the batteries are charged sufficiently, and are then thrown on the line to carry the day and night loads, which are exceedingly light, consisting of the station lights and such lights as are necessary at the home, excepting when the 8-horsepower motor is started up to pump water to the house tank, or when the elevator is used. The evening load is but 30 amperes. During extremely cold weather one engine is run with a 30-ampere lighting load and a 50-ampere storage load. The exhaust steam, after passing through a separator and heater, passes on to the house, through the radiators, and returns to a receiving tank. During the daytime steam is used at reduced pressure when the engine is shut down.

The cost of operation has been as low as $360 per month, and never above $416. This includes the salary of the engineer and fireman, cost of coal and all supplies, and giving a 24-hour service at that.

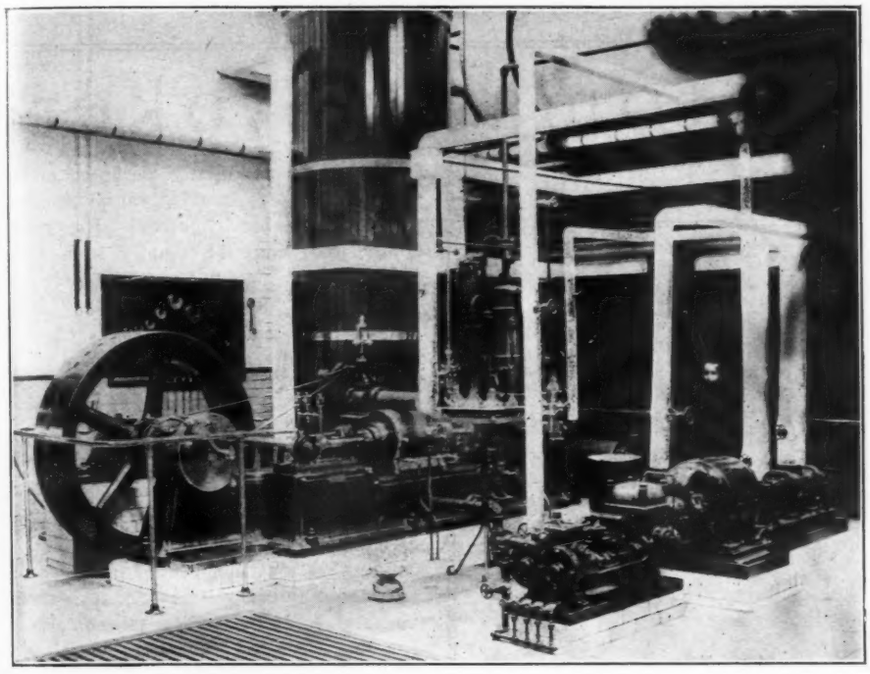


FIG. 3. REFRIGERATING PLANT

REFRIGERATING SYSTEM

The refrigerating room is shown in Fig. 3, in which is installed a De La Vergne one-ton steam-driven compressor of the double-acting horizontal type. On this machine the steam cylinder is placed next to the crank and a slide valve used in the steam chest. The compressor piston is attached to the extended end of the steam piston rod, the steam and ammonia cylinders being set tandem to each other.

A double-pipe condenser is used, the cooling water being handled by the 5¼ and 3¼ by 5-inch Dean Duplex pump shown in the foreground. The brine is circulated by a Quimby rotary pump, which is driven by a direct-current 5-horsepower General Electric 220-volt motor, running at a speed of 600 revolutions per minute. The brine is circulated from the plant to the house, where are located six ice boxes for the storage of provisions and eight ice cans. Up to the present time the refrigerating system has not been operated.

PUMPS

Under the floor grating, shown in Fig. 3, is located the pump pit, in which are placed steam pumps for handling the water for the laundry and delivering the waste water to the filter bed, also for pumping out the house cistern to the filter bed. From this pump pit a pipe tunnel leads to the home, which is of sufficient size to allow a man to pass through.

Feed water for the boilers can be obtained from the house tank, which is supplied from the deep well, or from a pond reservoir. The pumps in the pump pit are both connected to the suction pipe of the boiler-feed pump, so there are three means of supplying the boiler with feed water.

BOILER ROOM

The boiler room contains two 100-horsepower return-tubular boilers and a boiler-feed pump. The base of the stack, which is 6 feet in diameter and 100 feet high, is located between the second boiler, shown in Fig. 4, and the wall separating the boiler and refrigerating room. Each boiler is equipped with an Argand blower, alarm water columns and other necessary equipment.

The coal used in the plant is delivered direct from coal cars which are run on a trestle over the covered coal bins located outside of the boiler room. The bins hold about 200 tons of No. 2 buckwheat coal. Doors in the boiler-room wall

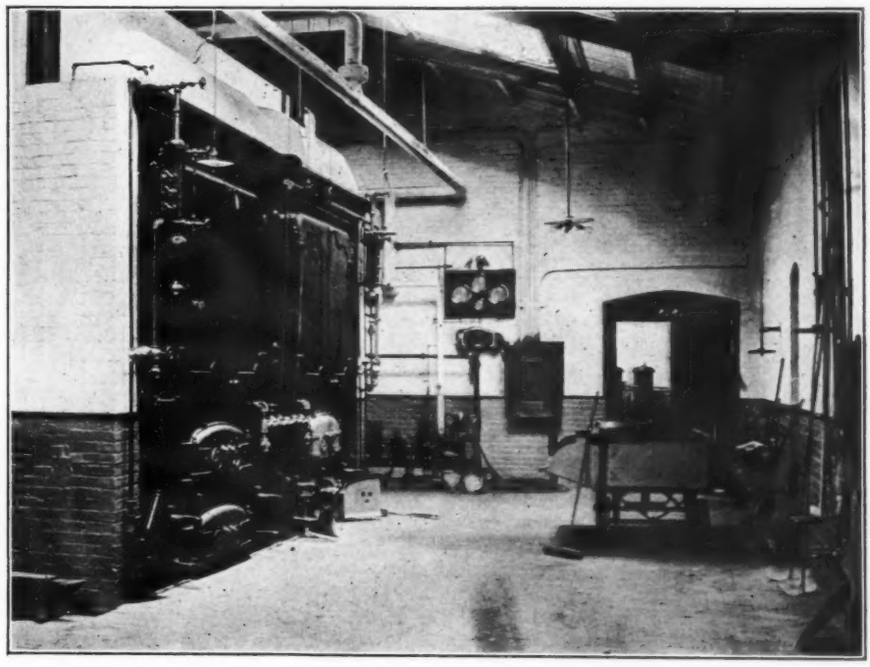


FIG. 4. BOILER ROOM

permit of the passage of the coal truck, shown in front of the boilers, and as these entrances are provided with doors, the dust and dirt are kept out of the boiler room. But one boiler is used at a time, and is fired but lightly, except when the engines are running full load. Next to the boiler setting is a motor-driven lathe, while at the extreme end of the boiler room is a stock room.

The various rooms are well lighted and painted white with a dark-colored wainscoting, bordered by a dark-red strip. The steam pipes are all protected by pipe covering, the bright work kept polished, and all in all the outfit is about as complete as can be found in a plant of so small capacity.

Side Feed Automatic Stokers

By J. F. Springer

In the side-feed stoker the fuel is fed onto the grates from each side of the furnace. The grates are inclined toward the middle of the furnace so as to form a V-shaped cross-section. A combustion arch extends across the grate above the open end of the V. With this construction, space is economized and good combustion secured.

A consideration of the devices described in the preceding article will disclose the fact that in England prior to 1850 most of the fundamental stoking ideas were germinated. The idea of feeding the fuel to the under side of the fire appears more than once. The conception of a longitudinal, inclined grate down which vibrating bars assist gravitation to secure a movement of the fire to the rear of the furnace, found expression in one or more patents obtained by William Brunton. These constituted front-feed stokers. The idea of carrying the fire along on a horizontal ribbon was developed by John Juckes into a true, chain-grate stoker. The device of flipping the coal, in small amounts, over the surface of the fire was evolved by John Stanley.

The only important stoking idea that, in recent years, has been developed, the fundamental character of which was not anticipated in the first half of the nineteenth century, is, in so far as the writer is aware, the side-feed furnace. This conception is, perhaps, not fundamentally an American one, but it has received considerable mechanical development and commercial application in the United States. The same may be said of the under-feed, the front-feed and the chain-grate ideas; every one of them has been carried to a state of great perfection in America.

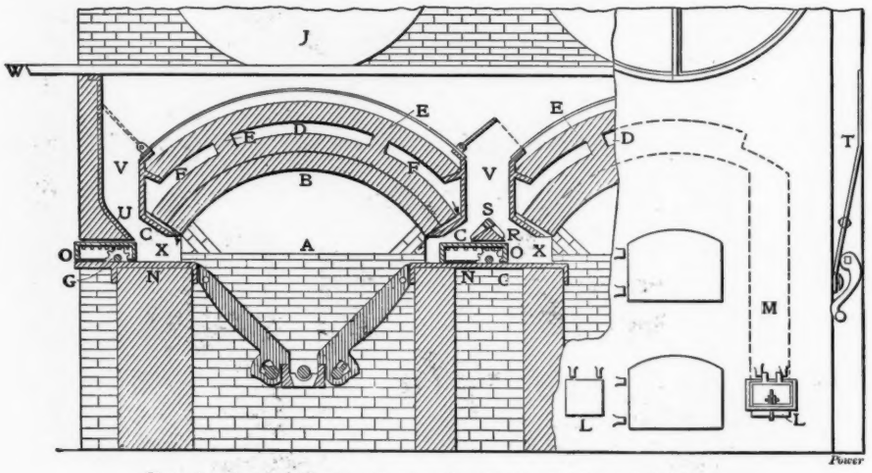


FIG. 1. FRONT VIEW OF THE ORIGINAL MURPHY FURNACE

The action, in respect to combustion, of the old Murphy design, as disclosed in the United States patent issued in 1879, is not unlike that of the British device of Brunton patented in 1819. It will be remembered that Brunton provided an air supply for the consumption of "smoak" independent of that for the fire itself. This was accomplished by means of an annular space between his rotating grate and the furnace wall. In the American design by Murphy, there are also two independent sources of air supply. The furnace and stoking arrangement are, however, quite different. As Murphy's is one of the fundamental designs, it will be well to consider it closely.

The view in Fig. 2 shows the general arrangement. The arch *B* forms the roof of the furnace chamber and extends across its entire width. The ends of the arch rest on corrugated or fluted pieces. In this way are provided radial openings into the furnace chamber. The corrugated plate may be plainly seen at *C*. Referring to Fig. 1, it will be seen that the orifices formed by means of these corrugated plates, open above into side spaces or flues arranged in the arch itself. There is also a central flue *D* separated from the side flues by partitions *E*. The flues open into each other at the rear of the arch as may be seen in Fig. 2. Further, small openings connect these flues with a flame chamber *I* at the rear of the arch. This flame chamber is bounded at the back by the bridgewall *K* and communicates with the furnace *A*. The end *J*, of the boiler, is seen above. The flues in the arch have communication with the external air by means of an air passage *M*, indicated by dotted lines in Fig. 2, which opens at the front at *L*. Air passing in at *L* finds exit from the flues in the arch in two ways, one of which is through the corrugations into the body of the furnace, the other is through the rear perforations into the flame chamber. This air supply is entirely independent of that which feeds the fire proper. In Fig. 1 the furnace is shown in battery arrangement, the left-hand furnace being an end one. The side walls of the furnace chamber *A* are provided with horizontal feeding plates *N* upon which the coal is first deposited. This position is exposed to a very high temperature and supplied with a rather limited amount of air. The gases which arise from the coking fuel on the feeding plates receive a supply of oxygen from the air coming in through the openings at the bases of the arch.

To thrust the coking fuel onto the grates, mechanical pushers or stokers are arranged at the sides. These operate transversely with respect to the furnace. Essentially, a pusher consists of a bottomless box *O*, placed longitudinally to correspond with the length of the feeding plate *N*, bottom down. A rod extends through the box on which are arranged pinions *G*, one at each end. These engage racks suitably arranged on the under surface of the top of the box. By operating the rod, the box or pusher is made to travel transversely across the feeding plate. Its surface is freed from coal by the scraper devices *R* and *U*, Fig. 1. A toothed slide *S* is arranged to clear the top of the scraper whenever any coke

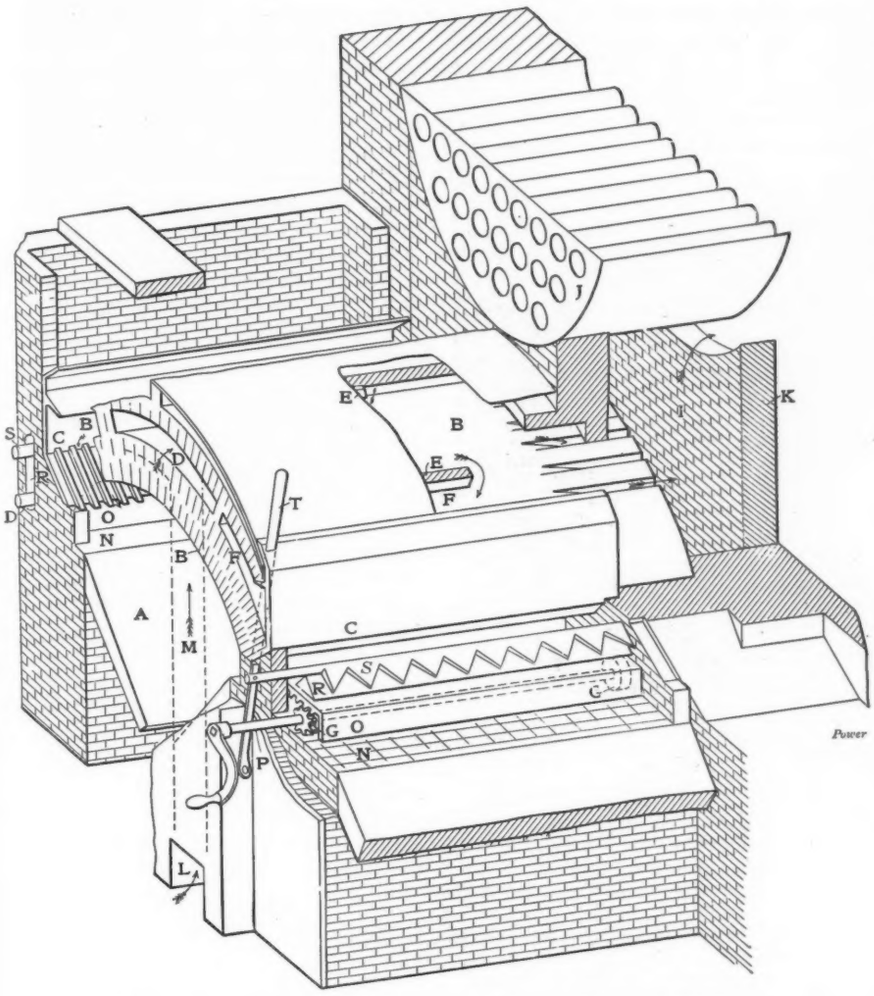


FIG. 2. PERSPECTIVE VIEW OF THE ORIGINAL MURPHY FURNACE

above and below the fixed grate surface. It will be noticed that this arrangement produces little or no disturbance of the under surface of the bed of coals at the top. This is thought to be quite advantageous for the reason that the fuel above is in the coking stage. Further, any considerable movement at the top would probably lead to loss of coal by sifting, unless corrected by other means. The grates are designed so as to tend to prevent loss arising from even the slight motion which the bars receive at the top. The fixed bars are provided with a series of horizontal ledges on each side, extending from the top to a point half way down their length. By this arrangement air is admitted and at the same time the fine siftings are caught. Below the halfway point it is desirable to have a greater air supply to the lower side of the bed of coal. When the coal, burning as it slowly descends, at last arrives at the bottom, it has been reduced to clinkers and ash and a large part of the ash has already been shaken out by the motion of the grate bars.

If we recall the V-shaped section formed by the grates, we readily understand that at each side of this pit compartments for receiving the siftings of unburned coal could well be arranged. This is, in fact, the arrangement adopted. When the mass of clinker mixed with ash has arrived at the point of the V, it finds itself upon a clinker grinder. This consists of one or two rocking cylinders provided with strong tooth-like projec-

adhering to it becomes troublesome. The slide is given a reciprocating motion by means of the lever *T*.

From the old Murphy idea have been evolved two present-day automatic furnaces. In the first Murphy furnaces the coking plate at each side was a single piece of metal. Experience soon disclosed that this design was impractical on account of the warping which took place. The warping at the center of the plate was, at times, sufficient to interfere with the incoming fuel supply. And so, present-day development discloses a furnace which breaks these coking plates up into sections of about a foot in length. This style of construction permits of inexpensive replacement of burned portions. Beneath the coking plate, as now installed, an air chamber is arranged which serves to cool this portion of the apparatus.

The fuel is still thrust off the coking ledges by reciprocating pushers, but it has been found advisable, also, to assist it in its descent down the grate surface by means of a rocking motion given to alternate grate bars. These movable bars are pinioned at their upper ends. At the lower extremities they receive a rocking motion which carries them alternately

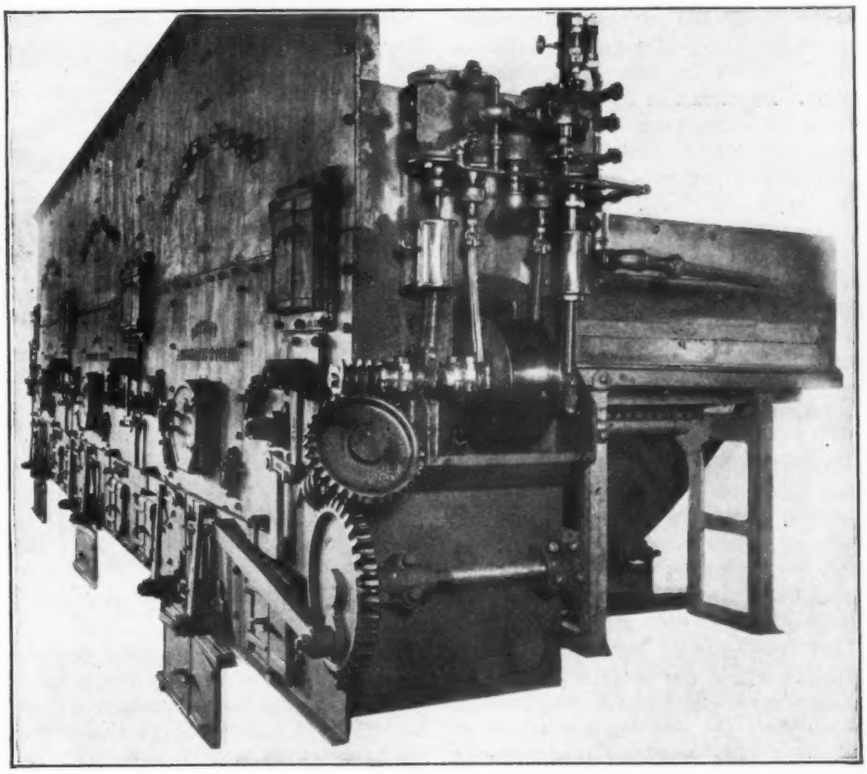


FIG. 3. EXTERIOR OF SIDE-FEED STOKER SHOWING OPERATING MECHANISM

tions. This device grinds the clinkers into small pieces. The original grinder consisted of a seamless tube carrying radial projections. Through this tube cool air was drawn in at one end in consequence of a connection with the smoke flue at the other. The construction was such that any serious damage to a part necessitated replacement of the whole. This style has now been superseded by a composite structure consisting of sections about 2 inches in width, assembled on a solid square shaft. These sections are provided with the projections which perform the actual crushing operation. By means of this sectional construction, the damaging of a tooth or two involves but a small expense. The frame which carried the grinding shafts in the type which has been superseded and which was so formed as to coöperate with the teeth of these shafts, was cast hollow. Exhaust steam from the stoker engine was supplied to the interior of the frame and found exit through perforations along the sides. This arrangement has been much changed recently. At present, the framework is not made hollow and the steam is introduced beneath the bed of clinker by independent tubing. These tubes receive the steam, as before, from the exhaust of the stoker engine. They are located beneath the axes of the grinders and connect with the smoke flue. Perforations are arranged along the top for the exit of steam. As their diameter is less than that of the grinders, their perforations are not subject to clogging although they open upward. The connection with the chimney imparts motion to the steam. The object of thus bringing in steam and discharging it beneath the clinkers is to soften them and prevent caking together and welding to the grinders. The former practice of passing a current of fresh air through the body of the grinder has been found unnecessary.

With regard to the furnace itself, the fundamental principle of introducing a supply of preheated air above the coking fuel has been adhered to in all the models. The baffling arrangements disclosed in the patent of 1879 have been somewhat modified. But the general procedure of conducting air back from the front and along the crest of the arch and above it and then permitting it to circulate forward along the sides has been retained, as also has the discharge of this heated air into the combustion chamber through nozzles or perforations at the bases of the arch.

With this type of furnace the amount of grate surface can be made large for a given floor area. When this design is compared with a horizontal grate, it will easily be seen that the length or breadth of the horizontal grate, or both, would have to be increased in order to preserve the same area of fire. The arch above and the inclined grates below form a series of reflectors which send the heat from one to the other in so far as radiation and reflection are concerned and thus is the loss of heat on account of dissipation by these processes limited.

In operating such a combination furnace and stoker, it has been found that the consumption of coal at the rear is greater than at the front. To meet this, coal must be fed in greater quantity at this point. But the consumption of more coal means the production of more clinker. So that the duty imposed upon the grinding apparatus is unequal along its length. A recent and patented improvement consists in the use of a tapered clinker bar to meet the varying duty placed upon it at different parts of the furnace.

As pointed out in the article on "Combustion" in POWER for May 10, 1910, it is necessary that time be allowed for the chemical reactions to take place. Other things being equal, time means space. And this the combustion chamber provides.

As to the mechanical operation, it will be observed that all the movements, the reciprocation of the coal pushers, the agitation of the movable grate bars and the rocking of the clinker grinders may readily be accomplished by the rotation of a series of parallel shafts. The communication of this movement is easily secured by a system of links driven by a single connecting rod. This arrangement may clearly be observed in Fig. 3.

A striking advantage of this style of furnace is that the coal is fed from above and along the sides and the stokers proper are contained within. These details are thus out of the way and so do not

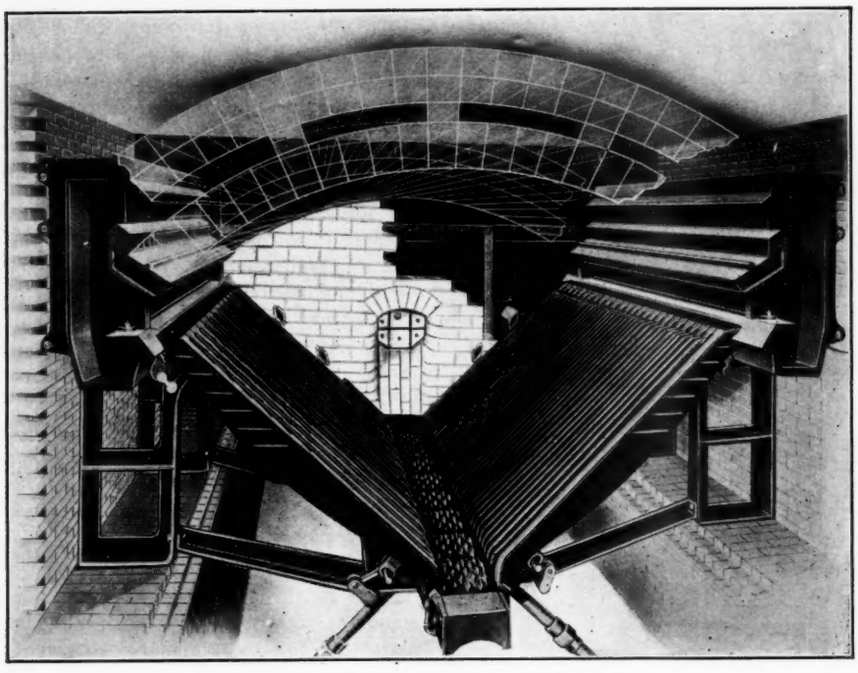


FIG. 4. INTERIOR OF SIDE-FEED STOKER

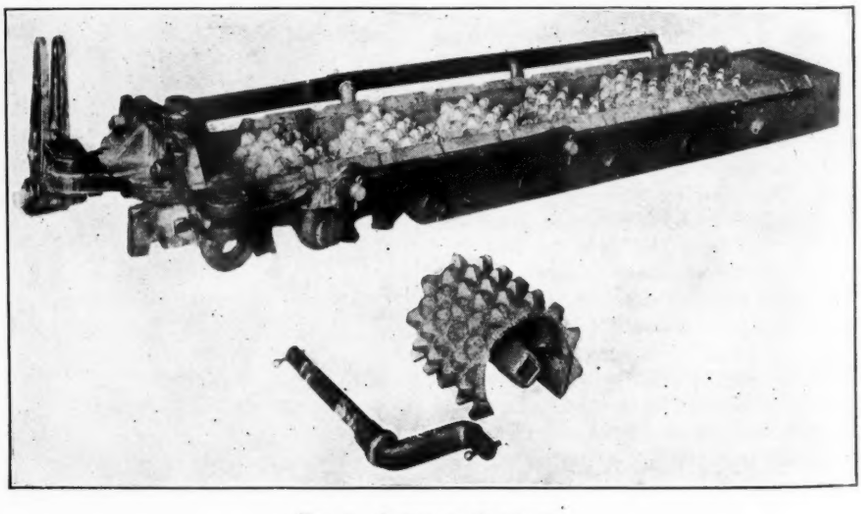


FIG. 5. CLINKER CRUSHER

hinder access to the parts of the furnace.

That the side-feed furnace and stoker is a commercial success may readily be understood when it is said that there have been installed apparatus of a single make corresponding to a total boiler capacity of 1,500,000 horsepower.

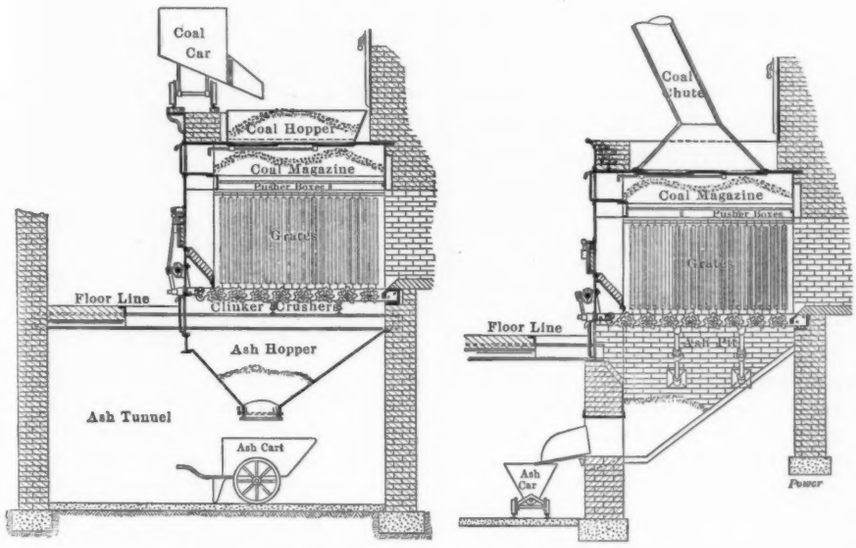


FIG. 6. TWO TYPICAL SIDE-FEED STOKER INSTALLATIONS

A modern form of this general type of combined stoker and furnace is shown in Fig. 4. The V-form of grate is, of course, apparent. The horizontal ledges on the grate bars which serve to prevent the sifting of fine coal not yet thoroughly heated and made to coalesce, are seen at the front. At the right, in the cast-iron skew back of the arch, are seen two rows of openings, square in cross-section. The upper row receives hot air from the heating chambers above the roof, the under row opens into the fuel chamber itself. By a study of the double arch shown at the left in phantom outline, the path of the air may clearly be understood. At the bottom of the V are a series of clinker crushers which coöperate with each other. These oscillate back and forth on transverse axes. This may be more clearly understood by referring to Fig. 5. Here one of the crushers is shown in the foreground. The crank shaft is shown separately close by. Assembled in the clinker frame, one-half of the shafts have their cranks at one side, the other half at the other, alternating with each other. The oscillation is accomplished by side bars. When one set of crushers oscillates forward, the other set oscillates backward; consequently, between any two crushers there is first a crushing action and then a releasing one. In Fig. 6 are seen two typical installations. These views are longitudinal vertical sections. The difference in the arrangements for delivery of the coal to the magazine will be observed. In one case, coal is brought up by a tram car, from which by a suitable spout the fuel finds its way into a hopper. In the other installation, delivery is made from an overhead magazine by means of a suitable chute. When the clinkers have passed through the crushers, they, together with the ashes proper, fall into ash chambers somewhat differently arranged in the two cases. In one, the ash chamber is a hopper delivering into an ash cart placed underneath. In the other case, there is a side delivery into a tram car. In Fig. 7 is shown a screw device which is used, or may be used if desired, instead of pusher boxes to secure delivery of coal from the magazine onto the grates. It will be noticed that this screw is tapered. This is for the purpose of securing delivery of a varying amount of fuel along the length of the grate in accordance with the variation in combustion. By referring to Fig. 3 an idea may be gotten of the mechanism by which the driving of the different internal devices is secured. The actual movements of a stoking apparatus are quite slow, consequently the reason for the use of the worm-and-gear device will be understood.

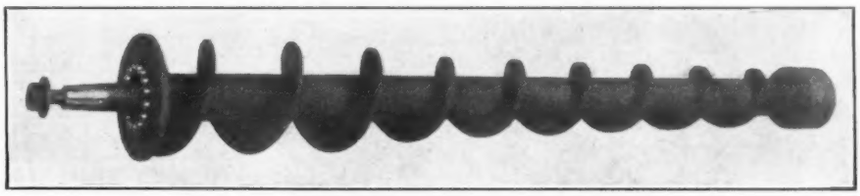


FIG. 7. WORM FOR FEEDING FUEL

Influence of Fire Cracks

By A. C. Waldron

One of my boilers, a 6x18-foot, double-strap butt longitudinal seam, ½-inch plate, has 13 fire cracks, Fig. 1, on the middle girth seam extending from the rivet hole to the edge of the plate, and does not show any leakage. This boiler for the past eleven years has been run day and night under the Parsons system of forced draft and is now in its second brick setting. One boiler-inspection company would allow but 100 pounds pressure, so another company inspected it and allowed 125 pounds, or precisely the same as is allowed on the boiler next to it which is the same size with the same thickness of head and shell and double-strap butt joint and which has only been run ten years, day times, and has never been in but one setting.

According to this we must take for granted that fire cracks "cut no figure" in the strength of a boiler. I know of a case where a boiler showed fire cracks and the inspector was called because of its continual leakage and advised simply to cut the cracks as in Fig. 2, ream the holes and renew the rivets, allowing the same pressure that had been carried for the past twenty years, and this was a lap-seam boiler. As there are many causes given for these fire cracks, such as the too free use of the drift pin and the sudden chilling of the edge of the plate in opening the doors while forcing the fire, and so on, it seems to me that the pressure allowed on the two boilers should not be the same. I would like to hear from some others on this subject.

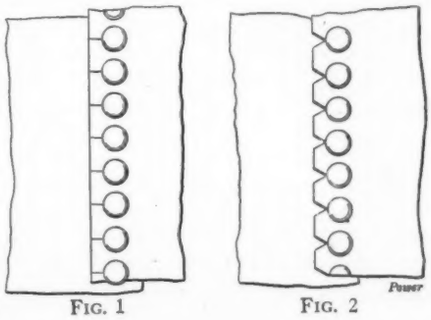


FIG. 1 FIG. 2

Friction Loss in Surface Condensers

By W. Vincent Treeby

The curves give the frictional head directly and save the time usually required to compute the frictional loss from the velocity of the water and the number of tubes in the condenser.

Frictional loss in a surface condenser has always been estimated from the velocity of the water and the length and number of tubes in the condenser, allowance being made for the friction in the water heads based upon the designer's experience.

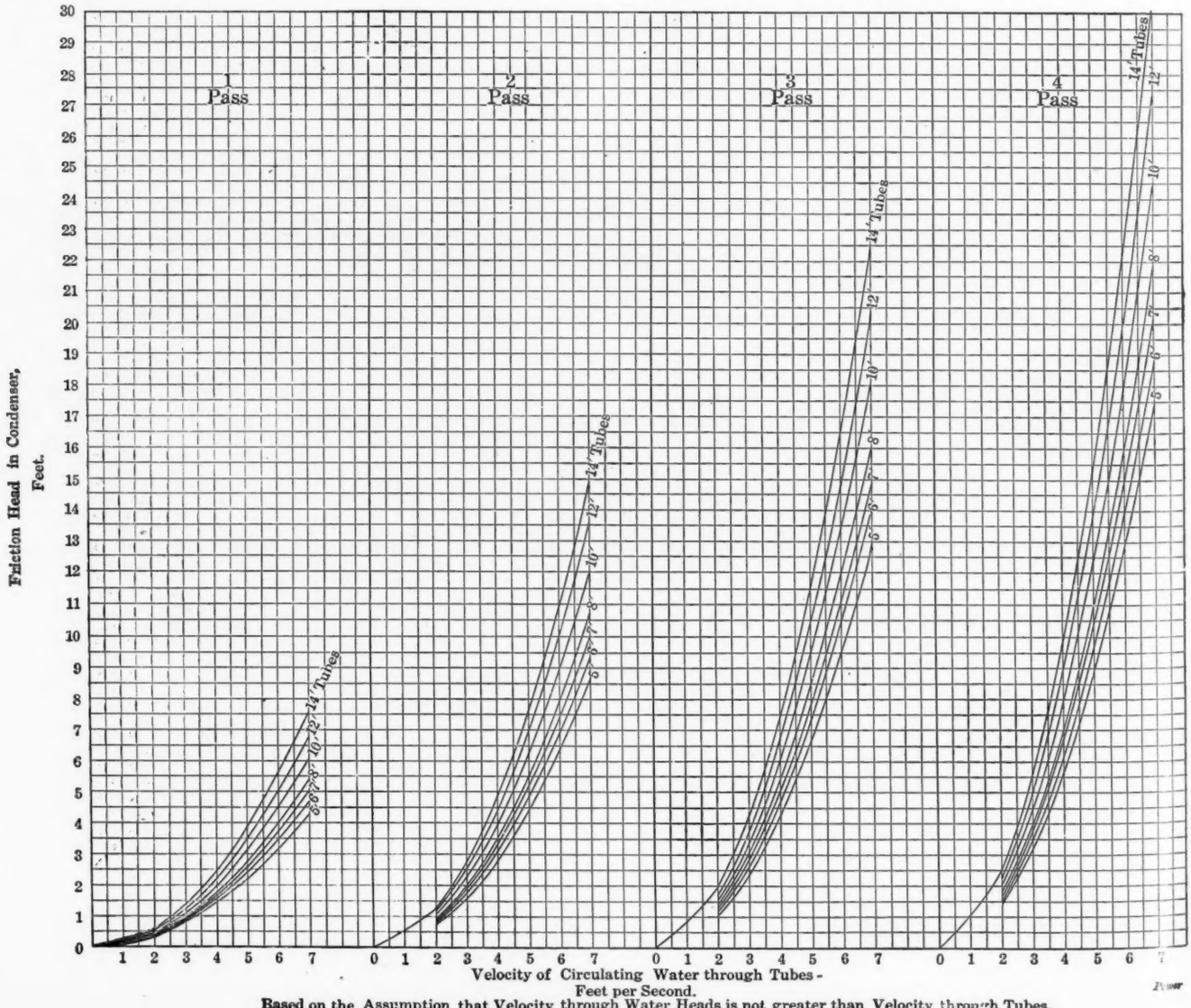
As this loss has always to be determined when designing a surface-condenser installation in order to fix the amount of power required to operate the circulating-water pumps, a series of curves, giving close approximations of the values of the frictional losses, should be of great convenience to the designer.

The curves given herewith are based upon theory and experiment combined and have proved to be very accurate in practice. The writer has, therefore, every confidence that in offering this information to fellow designers, it will save considerable trouble for them and, at the same time, give more accurate results than those obtained by the usual methods.

The curves require little explanation, the only question, perhaps, being what is understood by the term "pass." This refers to the number of turns the circulating water makes in flowing through the condensing tubes. Suppose the water entered the condenser at one end, flowed straight through the tubes and out at the other end. This would be called a one-pass condenser. Similarly, if the water, instead of passing through all the tubes, flowed in one direction through half the total number of tubes and then returned through the other half, leaving the condenser at the same end as that at which it entered, we would call this a two-pass condenser. It must be kept in mind that when this is done, we halve the area of water flow and, therefore, double the velocity.

If, for example, we commenced with a one-pass condenser, with water flowing at a velocity of 2 feet per second through ¾-inch o. d. tubes, 6 feet long, we would find, upon referring to the curves, that the frictional head in the condenser would be equal to 0.4 foot.

Now if we arranged the tubes so that the circulating water would flow through half the tubes to one end, then reverse and return through the other half, we would halve the water area, double the velocity and increase the frictional head to 3.1 feet.



Based on the Assumption that Velocity through Water Heads is not greater than Velocity through Tubes.
Note:- For ⅝" Tubes above should be multiplied by 1.4. 1" Tubes multiply by 0.9.

Dick Darrow's Daring Deed

That the general public has but a vague conception of the elements of steam engineering is well known among engineers. That it is to be blamed for this seems hardly fair when it is fed with such misleading and entirely ridiculous matter as is indicated by the accompanying extracts from a story which recently appeared in a magazine devoted to fiction.

It seems that old Jason, the operating engineer of Darrow's shoe factory, was full of regret that young Dick, son of the owner, had been sent to college and filled with theory while his practical training had been entirely neglected. It appears that Dick too had his doubts as to the value of a college education when the practical side is completely neglected.

However, Dick's selection of a college course rather than a shop training is shortly to be gloriously vindicated and old Jason is to find out that a knowledge of theory is not to be despised. Even as Dick sits in his office musing with sorrow upon his mistake, his chance occurs. Witness this:

"A pistol shot from the factory brought Dick to his feet with a sudden bound, or was it a pistol shot?"

No, it was not. To keep you no longer in suspense, the horrible truth is out—the engine was running away. A broken governor belt was the cause.

"Out in the engine room Jason tugged and struggled wildly with the throttle: it was set. * * * And the immense pressure of steam now pouring through from the boilers, meeting at that point the back pressure from the flying cylinder head, was perhaps as unyielding as though the valve were packed with so much ice. * * *

"Every plunge of the piston sent the speed of that dangerous flywheel *up another notch,* and rendered the *packed-in steam* about the *throttle* more irresistible.

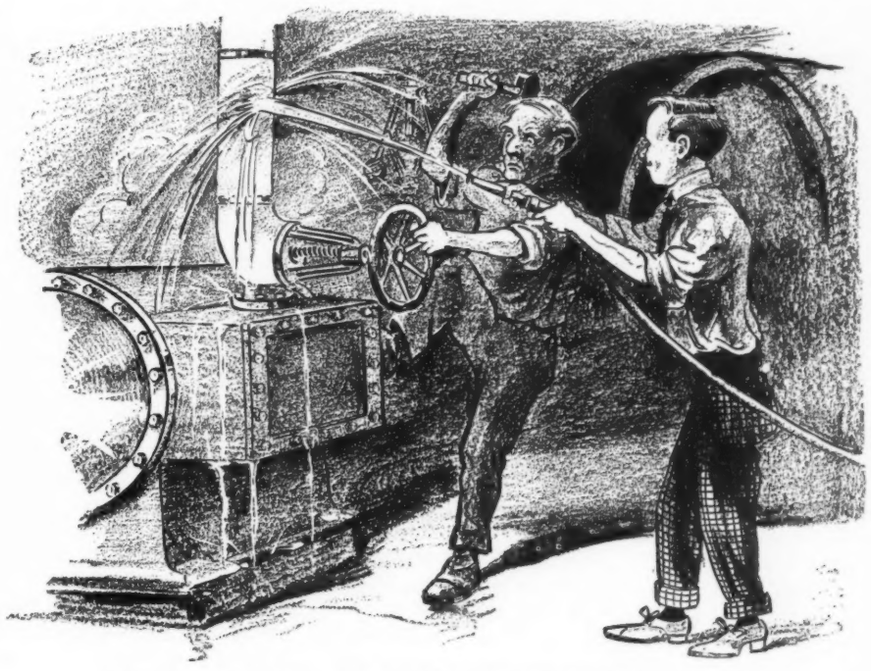
"Jason still struggled desperately with the stubborn throttle, the sweat pouring over his face and visions of killed and wounded people before his eyes. It was in vain. He might as well have tried to seize the ponderous balance wheel itself. *The back pressure, packed solidly into the valve,* held it open like an iron wedge. Here was a situation at last against which all his life-long experience did not avail him, because it was a new one. He was helpless, but game to the end. *He seized a hammer,* and *struck several sharp blows over the throttle,* hoping thereby to loosen it; then strained at it until the skin was twisted from his palms. The steam still poured in unchecked, and the *piston head pounded* away with increased speed at every revolution, at the same time *compressing the steam tighter and tighter against the throttle.* It was a time when the usual engine-room rules *amounted to nothing,* and when every instant was turning the danger point forward in great leaps.

"For an instant Dick, accustomed as he had always been to lean upon the skill of the old engineer in times of mechanical trouble, hesitated to take matters into his own hands in a crisis like the present. He saw that Jason was helpless; that all the rules and tried experiences of a long practical life were useless in the face of this new situation, and he felt that the responsibility to meet this strange condition was his own. Where engine-room practice fell short, he must depend upon his own book knowledge of the principles which underlie the entire force of steam. Nothing, it was plain, would ever turn that throttle until a vast amount of the *internal pressure was removed.* To reduce the pressure in the boilers, and so to decrease the supply in the pipes, would require more minutes of time than he had seconds to operate in. The *back pressure from the cylinder head could not be lowered until the engine was brought down to normal speed,* and that, of course, could not occur until the steam supply was cut off in some manner. There was absolutely nothing about the machinery itself to help him; but, from his own head, his knowledge of steam properties, he drew one fact and put it into practical application. *There was one other way of getting rid of steam, by condensation, reduced temperature.*

"Springing forward to the great fire hose, coiled neatly on its reel, Dick turned a full head of cold water upon the steam pipe a short distance above the throttle. A chilling flood at once rushed down over the hot pipe and the cylinder. For a moment, the *compressed steam* inside resisted the icy deluge; then it began gradually *to congeal,* only to be replaced by fresh steam from the boilers. The battle at first was sharp, but the superior quantity of the cold element soon began to gain headway, until the wedged throttle, relieved of its unnatural back pressure from the cylinder, yielded to the engineer's efforts, and turned in his hand. With a whirl, he spun the wheel around until the valve was crowded hard into its socket. The steam was off at last.

"Little damage had been done, after all, beyond the starting of innumerable bolts and the wrenching of a few braces, but it was nearly half an hour before friction overcame the momentum the machinery had gained, and finally brought it to a stop."

Hurrah!



TURNED A FULL HEAD OF COLD WATER UPON THE STEAM PIPE

Air Compressor Cylinder Ratios

By Snowden B. Redfield

Saving in power by compounding air compressor cylinders is a maximum when the work is the same in the two cylinders. Theoretically this is obtained when the cylinder ratio is the square root of the total ratio of compression, but in practical working imperfect intercooling necessitates making the cylinder ratio slightly less than this. This is based upon a calculated intercooler pressure three or four pounds less than theoretically required for regular work, this pressure then rising under practical conditions to give equal work and maximum economy.

Mechanical engineers seem never to tire of the discussion of the most suitable cylinder ratios for steam engines under various conditions of compounding. Even after an engine has been carefully designed so that equal work will be performed in each of the various cylinders, it is more than likely that the operating engineer, who has his own ideas on the subject, will so adjust the valve gear that the balance of work will be disturbed and he will point with pride to the fact that at peak load his indicator diagrams are bigger than they were before the valve gear was changed, or else that with normal load the governor is revolving in a higher plane than before, indicating that less steam is being used. The question does not seem to be settled as yet, and probably never will be, so long as different men continue to hold different opinions.

This unsettled state of affairs for steam engines has sometimes been dragged into the field of air compression by these enthusiasts, and when the air-compressor designer states that the minimum work for air compression will be required when the work in the two air cylinders of a compound compressor is alike, the enthusiast immediately refutes this statement with an argument and description of what he has done with the valve gear of a steam engine to alter the ratio of expansion in the cylinders.

Not Comparable to Steam Cylinders

Such arguments are utterly useless, because the subject of compound air-compressing cylinders is not related to compound steam engines, as the conditions in the two cases are entirely different. Numerous excuses are given for the compounding of steam engines, and there are those advocates of the single-cylinder steam engine, who state that if given equal conditions, there is no advantage to be obtained by compounding a steam engine at all.

With an air compressor, however, there is an actual saving in the work performed to compress a given quantity of air to a given pressure when this is accomplished in two or more stages and suitable construction is provided for properly cooling the air between the stages. This also assumes that sufficient valve area is given to the compressing cylinders to allow the air to come into and go out of the cylinders without undue throttling.

Saving due to stage compression in an air compressor is due solely to the possibility of cooling the air between the several stages. If there is no cooling between the stages, there is no saving in the power required to compress and the work might just as well be done in one cylinder; in fact it would be more economical under those circumstances to do the work in one cylinder rather than in two.

Ratio for Equal Work

On the right of the accompanying chart will be found three theoretical adiabatic indicator diagrams of a compound air compressor pumping from atmosphere to 100 pounds gage pressure with various cylinder ratios. In the case of the middle set of diagrams the cylinder ratio is made 2.794, this being the square root of the total ratio of compression, which is 114.7 divided by 14.7 or 7.8. Under perfect adiabatic conditions, if the ratio of the cylinders of a compound compressor is equal to the square root of the total ratio of compression, the ratio of compression in each of the cylinders will be the same as the cylinder ratio, and the work in the two cylinders will be alike. Furthermore, under such conditions, it is a fact that the total horsepower necessary to be developed by the compressor to deliver the air to the given pressure will be a minimum. In other words the saving by compounding will be a maximum.

Noting the central indicator diagram at the right of the chart, it will be seen that compression is carried up along the adiabatic line from atmosphere to the intercooler pressure which is 26.4 pounds gage. This pressure is obtained by multiplying the absolute initial pressure, 14.7, by the cylinder ratio, giving the absolute intercooler pressure. Subtracting 14.7 from this gives the gage pressure. This is due to the fact that all the air entering the low-pressure cylinder must go into the high-pressure cylinder after cooling to the original temperature and at equal temperature the absolute pressures are inversely proportional to the volumes. At this point the air passes out of the low-pressure cylinder and into the intercooler, which is supposed to be provided with sufficient cooling surface and sufficient cooling water to reduce the temperature of the air, which by the way, would have been about 240 degrees Fahrenheit, down to the original temperature of the atmosphere. When the temperature of this air has been reduced to that of the atmosphere, its volume will also have been reduced as is shown by the shaded area of the indicator diagram under consideration. This reduction in the volume of the air is exactly where the saving of power takes place by compounding the compression.

Compression in the high-pressure cylinder follows up the adiabatic line as shown, until it eventually meets the 100-pounds pressure line, when the air is discharged from the cylinder. In the central diagram, the shaded area below the 26.4 pounds pressure line represents the work done in the low-pressure cylinder, and the shaded area above this line represents the work done in the high-pressure cylinder. Under the imposed conditions these two areas will be exactly alike. That portion of the diagram which is unshaded represents the amount of work which is saved by compounding over and above what would have to be done if the compression were in a single stage. If the compression were in a single stage the full area would represent the work that would have to be done by the compressor.

Low Cylinder Ratios

As the statement has been made that the conditions represented in the central indicator diagram are such as will give minimum total work, it follows that with any other cylinder ratio the work done by the compressor upon the air will be greater than this. Glance next at the lower indicator diagram shown in the chart. In this case the cylinder ratio is made 1½, in other words the low-pressure cylinder has only 1½ times the volume of the high-pressure cylinder. It will then be found that the intercooler pressure will be equal to 7.3 pounds gage, and the work done in the low-pressure cylinder will be represented by the

shaded area under this line. After passing the air out of the low-pressure cylinder and into the intercooler, the air is supposed to be reduced again to the original atmospheric temperature, and in so doing, as before, the volume of the air will be reduced. Now, however, since the ratio of compression in the low-pressure cylinder, which is the same as the cylinder ratio, in a theoretical case, is only 1½ instead of, as in the previous case, 2.794, it follows that the temperature of the air just before leaving the low-pressure cylinder is not so high as in the first case considered. The temperature being already low, there is not so great a reduction in temperature possible in the intercooler and consequently there is not so much reduction in volume by the process of intercooling. The result of this is perfectly logical, that is, that there is not so much saving in compounding in the case under consideration as there was in the first case, when the work was equal in the two stages.

As graphically illustrated in the lower diagram, compression in the high-pressure cylinder follows up the adiabatic compression line until it finally reaches 100 pounds pressure. The work performed in the high-pressure cylinder is then represented by the upper shaded area. As before, the work saved by compounding is the unshaded portion of the diagram, but it is easy to see that this unshaded portion is very much less than the unshaded portion of the middle diagram, or in other words, the saving in work is less than before, as surmised from the temperature considerations.

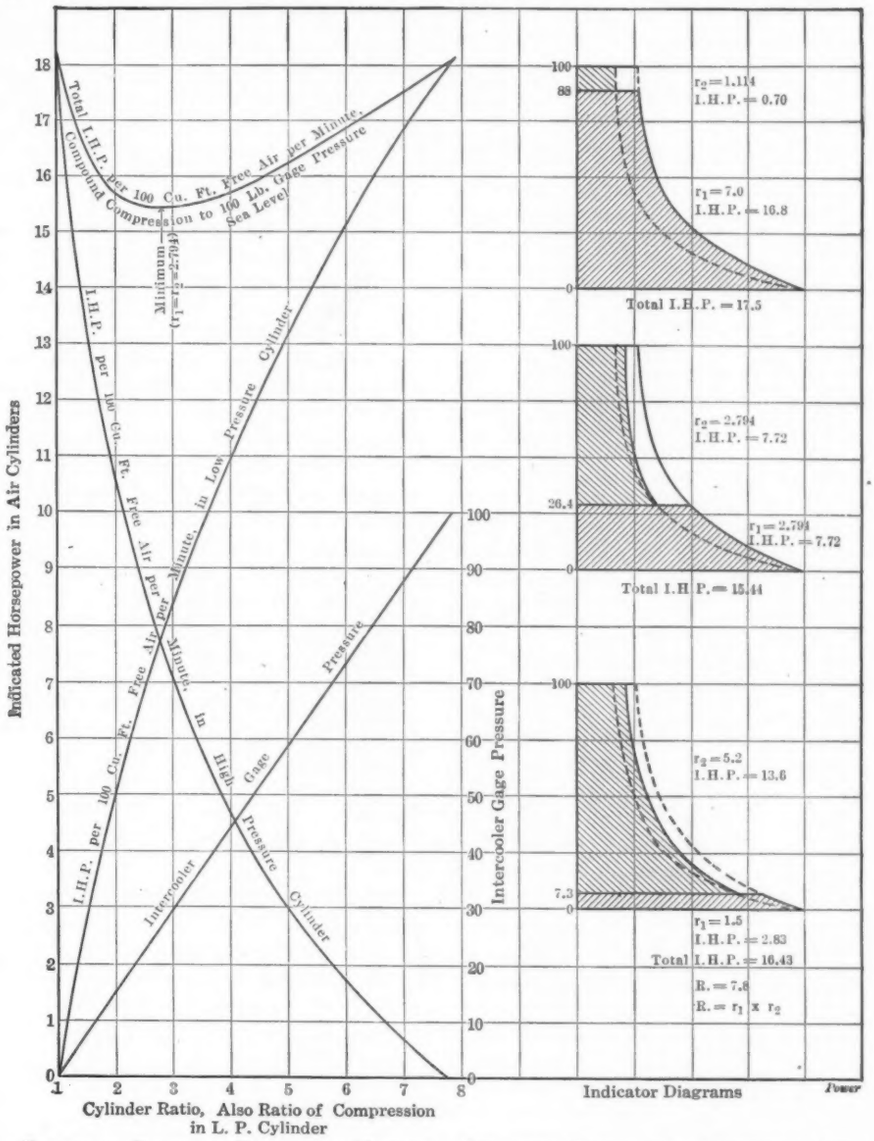
Suppose now that this condition were exaggerated still further, the cylinder ratio being made, say, 1¼. This would bring the intercooler pressure still lower, causing the compression in the high-pressure cylinder to begin nearer the right-hand end of the diagram. The unshaded portion, representing the saving, would be still narrower, until finally, with a cylinder ratio of unity, the intercooler pressure would be atmospheric and all of the work would be performed in the high-pressure cylinder. The compression would then be single stage and the unshaded portion representing saving, would have disappeared entirely. Under these circumstances, the work required to compress the air would be equal to that which would be required to compress it in a single cylinder from atmosphere to 100 pounds pressure.

High Cylinder Ratios

In the top diagram in the chart the other extreme will be noted. In this case the cylinder ratio is made 7 to 1, in other words, the low-pressure cylinder volume is seven times as great as that of the high-pressure cylinder. In this case, as is easily seen by noting the shaded area, the vast preponderance of work is done in the low-pressure cylinder and the intercooler pressure is at 88 pounds. The shaded area above this line represents the work done in the high-pressure cylinder and this will be seen to be very small indeed, compared to that done in the low-pressure cylinder. Furthermore, the unshaded area representing the saving in work due to compounding, is very much smaller than it is in the central set of diagrams, showing again that the economy is not so great as in the case first considered, when equal work in the two stages was assumed.

Varying the Ratio

As will be seen by the three sets of indicator diagrams, the horsepower in the two cylinders varies with the cylinder ratio and the total horsepower performed also varies, this being the sum of the two. Of course, other cylinder ratios than those shown in the diagrams could be figured out and the total horsepower in the different cases noted. In fact, this has been done and the results are plotted graphically at the left side of the accompanying chart. At the bottom of this set


Indicated Horsepower in Air Cylinders
Intercooler Gage Pressure
Cylinder Ratio, Also Ratio of Compression in L. P. Cylinder
Indicator Diagrams
Total I.H.P. per 100 Cu. Ft. Free Air per Minute, Compound Compression to 100 Lb. Gage Pressure Sea Level
Minimum I.H.P. = r1 = r2 = 2.794
I.H.P. per 100 Cu. Ft. Free Air per Minute, in Low Pressure Cylinder
I.H.P. per 100 Cu. Ft. Free Air per Minute, in High Pressure Cylinder
Intercooler Pressure
High Gage Pressure
r2 = 1.114
I.H.P. = 0.70
r1 = 7.0
I.H.P. = 16.8
Total I.H.P. = 17.5
r2 = 2.794
I.H.P. = 7.72
r1 = 2.794
I.H.P. = 7.72
Total I.H.P. = 15.44
r2 = 5.2
I.H.P. = 13.6
r1 = 1.5
I.H.P. = 2.83
Total I.H.P. = 16.43
R. = 7.8
R. = r1 x r2
Power

Diagrams Showing Effect of Various Cylinder Ratios for Compound Air Compression to 100 Pounds Pressure

This condition again could be exaggerated still further, making the cylinder ratio, say, ½. In this case the intercooler pressure would be still higher, the work done in the high-pressure cylinder would be still less and the unshaded area representing the saving, would be further decreased until as a final condition, this saving would entirely disappear in the low-pressure cylinder. This work would again be the same as if the compression were single stage as performed by a single-cylinder compressor.

of curves, there are marked the various cylinder ratios, or the number of times the volume of the low-pressure cylinder is greater than that of the high-pressure cylinder. This ratio is carried out from unity, where the two cylinders would be the same size, all the way up to a final cylinder ratio of 7.8, this being the total ratio of compression for compressing air from atmosphere to 100 pounds gage pressure at sea level.

As these ratios increase, it will be found by noting the lines showing the

horsepower of the two cylinders, that the indicated horsepower in the low-pressure cylinder is increasing from 0 with a cylinder ratio of unity, to a maximum of 18.1 with a cylinder ratio of 7.8. At the same time that this increase in power is occurring in the low-pressure cylinder, a decrease is occurring in the horsepower of the high-pressure cylinder. With a cylinder ratio of unity all the work would be performed in the high-pressure cylinder, this amounting to 18.1 indicated horsepower and dropping off according to the curve until, with a cylinder ratio of 7.8, it finally reaches zero. In each cylinder the horsepower is figured for 100 cubic feet of actual free air at atmospheric pressure, per minute.

Minimum Horsepower

Examining the upper curve marked "Total indicated horsepower per hundred cubic feet of free air per minute," etc., it will be found that the minimum total horsepower occurs for 100 pounds final pressure when the cylinder ratio is 2.794 and the ratio of compresson in each of the two cylinders is alike and also equal to 2.794. At this point the horsepower in the two cylinders is alike and equal to 7.72, the total horsepower, of course, being 15.44 per hundred cubic feet of free air per minute. On each side of this minimum point the horsepower increases up to that required for single-stage compression to 100 pounds pressure, namely 18.1 horsepower per hundred cubic feet of free air per minute.

As a matter of fact, the curve of total horsepower is so very nearly flat over a considerable range of cylinder ratios, that a good deal of variation is possible without increasing the total horsepower performed to any noticeable extent. A glance at the upper curve in the chart will show that for cylinder ratios varying from about 2 to 3.5, the total horsepower is practically the same. However, this variation of cylinder ratio considerably unbalances the machine, so that with a cylinder ratio of 2, while the work done in the low-pressure cylinder is only 5 horsepower per 100 cubic feet of free air per minute, that performed in the high-pressure cylinder at this ratio is about 10.6. With a cylinder ratio of 3.5, the work performed in the low-pressure cylinder is about 9.8, and that in the high-pressure cylinder only 5.8. In each of these cases the total horsepower is the same: 15.6.

As long as the total horsepower is only slightly affected, the question may then be raised; what difference does it make if the machine is unbalanced? The only difference is this; that in designing a compressor it is to be presumed that the bearing surfaces are calculated for certain total pressures per square inch of projected bearing area to give satisfactory lubrication for tool running. If then 100 per cent. more work is thrown upon one side of the machine than upon the other side, the machine is not running under favorable conditions, and that side which is doing the most work is more than likely to develop a hot bearing unless the bearings and pins are constructed accordingly. In this case either one side is overloaded and the other underloaded or else the machine must be made "lop sided," which can hardly be considered economical design.

So far a pressure of 100 pounds and compound compression only, have been considered, but all the arguments hold good for any other pressure and for any number of stages of compression. For three stages, the cylinder ratios would be the cube root of the total ratio of compression. For four stages the ratios would be the fourth root of the total ratio.

Practical Considerations

All of this is theoretical, but the effect of practical working is simply to add a small quantity to the horsepower developed in each cylinder, and consequently to the total horsepower, this additional work being caused by the necessity of forcing the air into and out of the cylinders through the valve passages. In ordinary working, however, it is found that perfect intercooling is never attainable. In other words the air passing through the intercooler is never reduced entirely to the original atmospheric temperature. The effect of this is to slightly raise the intercooler pressure above that which would be obtained if theoretical conditions could be secured in the operation of the compressor.

Slight raising of the intercooler pressure will, of course, throw more work on the low-pressure cylinder, decreasing that done in the high pressure and slightly increasing the total work of the two cylinders. In order to obviate this condition, it is considered good practice in compound air-compressor design to make the cylinder ratio a little less than the theoretical ratio for equal work, so as to give an intercooler pressure, which theoretically would be about 3 or 4 pounds less than that which equal work would dictate. This applies also to three, four, or any number of stages, the pressure allowance increasing with their number. It then happens with practical conditions and imperfect intercooling, that the intercooler pressure will be raised above that which would be calculated from the cylinder ratio, approaching more nearly to theoretical conditions, giving a minimum horsepower, a more balanced compressor and consequently a more economical design from every standpoint upon which efficiency depends.

The Proper Fitting of Engine Cranks

By H. S. Brown

At some time in his career most every engineer is called upon to replace a crank which has become worn or broken. He must acquaint himself with the details of refitting or a second accident is likely to occur.

The designing, casting and finishing of steam- or gas-engine cranks does not seem to have received proper attention if we are to judge from the numerous accidents referred to in POWER during the past few years. In some cases the crank has cracked from shock caused by water in the cylinder, sudden overload, and quickly reversing the engine. In other cases the pin has worked loose, or the crank has moved on the shaft. In most cases temporary repairs may be made to tide over until a new crank can be obtained, which is sure to be necessary later on.

If the engineer in charge is to undertake the job of replacing, or give instructions for the same, he must acquaint himself with the details or a second accident is likely to occur. I have known of two and three cranks being fitted before success was attained.

Allowing for Shrinkage

After a crank has been cast, careful attention in the matter of finishing is required. The shrinkage allowance is of equal importance with the selection of material for the casting. In many shops the shrinkage is entirely left to the mechanics. This is a mistake, as there are but few, comparatively speaking, who understand the very important element of elasticity in metals.

I have witnessed a great number of cases in which the crank has seized on the shaft when only a few inches on. In others the crank cracked in cooling, and in other cases, the crank has worked loose on the shaft after a few months' service. There is not one man in a thousand who can take measurements from a shaft and bore a casting with the proper allowance for shrinkage, with the ordinary shop calipers, as it is all guess work. If micrometer calipers are

not at hand the engineer should have a gage made, as shown at *A*, Fig. 1.

I have found 1/1000 inch per each inch of shaft diameter a safe allowance. With a 10-inch shaft this means only 1/100 inch for shrinkage. After this gage has been finished, a second or male gage should be carefully fitted, as shown at *B* and *D*. If these gages are to be sent to the shop where the crank is to be bored, exact duplicates should be retained by the engineer, as a precaution against loss or accident to those sent away. The gage shown at *B* should be of ½-inch to ⅝-inch square steel, and the points should be on one side, as shown at *B*, for convenience in measuring. This will be readily understood by referring to *C*, Fig. 1, where the points are in the center. The reason for the extra care in the allowance for shrinkage is to guard against overcoming the elastic limit of the iron. If we increase the shrinkage to the point at which the elasticity of the iron is overcome by the stretching process there will be a fracture at the weakest point.

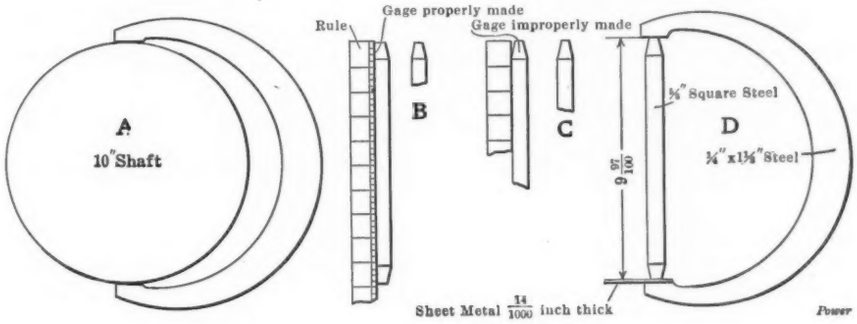


FIG. 1. GAGE FOR MEASURING SHAFT

The hub is where the greatest strength is required; and as the thickness of the iron increases, the center of the section is more open in the grain. This is shown in the half section of the crank, Fig. 2. The hub is more open in grain and weaker than either the web or rim flange.

From the fact that in many cases of accident to cranks the fracture starts in the key way, it is better to have it located in the bore opposite the crank pin, as shown in Fig. 2. The reason for this is, that the extra metal in the counterbalance gives it a stronger backing.

FITTING THE KEY

In fitting the key it should be filed and scraped to a perfect bearing its entire length and on all sides. This gives one solid mass of metal between the shaft and crank.

The key should never be of soft steel, as it will upset and change its form while being driven home. A drift should never be used in fitting a crank key, as there is danger of bruising the main bearing of the shaft. The drift will also upset the end of the key and destroy the fit. It is better to forge the key on the end of the bar and turn up a gib end to drive against in drawing the key out. In cases where the crank pin is riveted on the end it is better to make a new one, as the riveting must be cut away for refitting and this shortens the bearing in the crank. It is also more likely that the old pin has worn out of round and somewhat smaller in diameter, which means that the connecting-rod boxes must be renewed or babbitted, and futher, that in reducing the pin diameter, the bore in the crank must be reduced. These form a weak point that may cause a second accident later on. The pin should be fitted and shrunk in at the same time the crank is put on the shaft; the same heat will answer for both. The crank should be heated slowly and evenly all over to prevent its changing its form, and also to remove all shrinkage strains.

If a new pin is put in, the steel should be of fairly high carbon for strength and wear. A safe analysis is given on page 639 of April 6, 1909, POWER.

In a recent issue I noticed a case in which a crank was warmed up and then drawn on the shaft by means of bolts and clamps. Such practice is very dangerous, because as it is a slow operation the shaft will warm up while the crank will cool down, and the crank is liable to stick fast. I have seen this tried with the result that the casting had to be split to get it off and a new one fitted.

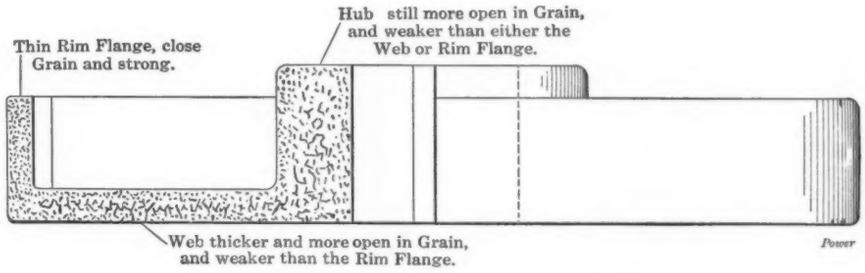

Hub still more open in Grain, and weaker than either the Web or Rim Flange.
Thin Rim Flange, close Grain and strong.
Web thicker and more open in Grain, and weaker than the Rim Flange.
Power

FIG. 2. HALF SECTION OF THE CRANK

With proper design, proper composition in the metal in the casting, and a proper allowance in shrinkage, and the casting put on by heating, not drawn on by bolts and clamps, the engineer need have no fear of the result.

Consul Augustus E. Ingram, of Bradford, suggests that the following British idea would be worthy consideration by American concerns issuing catalogs: An Engineers' Standardized Publications Association has recently been formed, having its headquarters at Craven house, Kingsway, London, W. C. Its object is to persuade manufacturers to conform to mutually agreed standards in the size and arrangement of price lists and catalogs, and facilitate reference to these publications by scientific classification of their contents. While the shape and size of catalogs may seem a small matter, yet anyone, and especially a consular officer, who has attempted the classification and arrangement of the catalogs issued by American manufacturers and exporters will appreciate the great difficulty of making an orderly collection of them. The result frequently is that the catalogs are not as carefully preserved as they should be and, therefore, fail of carrying out the full purpose of their mission. When one considers the outlay on these publications, which are often handsomely and expensively gotten up, and the heavy expense of postage, the advisability of taking all possible steps to insure not merely a momentary welcome and appreciation, but a permanent place in a reference collection, is self-evident. This is the age of filing cabinets, which are more or less of uniform size, and American manufacturers and exporters might with profit consider this matter of standardizing their price lists and catalogs.

According to Lloyd's Register for 1909-10, recently published, it appears that the ocean tonnage of the world amounts to 41,449,767 tons as compared with 40,922,842 tons one year ago.

Electrical Department

Cheating the Electric Meter

By C. Howard

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

Having spent several years as a tester and an inspector of recording watt-hour meters, I have run across a good many cases of cheating by users of current from central stations. Some of the methods of stealing electric power are described in this article.

The method shown in Fig. 1 is taken up first because this is tried more frequently than others and this type of meter is used to a greater extent than any other type. The diagram shows clearly how a customer can use power without registering on meter. That fuse of the house fuseblock which is connected to the neutral of the street main is removed, a dummy fuse (one which does not bridge the contacts) is inserted in its place, and that side of the house wiring is grounded, as shown. As the neutral of all three-wire systems is grounded, the lamps will burn with full voltage but the meter will not record as there is no current through the field winding of the meter. In order to prevent this method of cheating, meters should never be connected with the field winding in the neutral and the through "bus" in the outer conductor of the system. It might seem that a case of this description is easily discovered, but when the wiring in the house is all concealed and the ground connection hidden

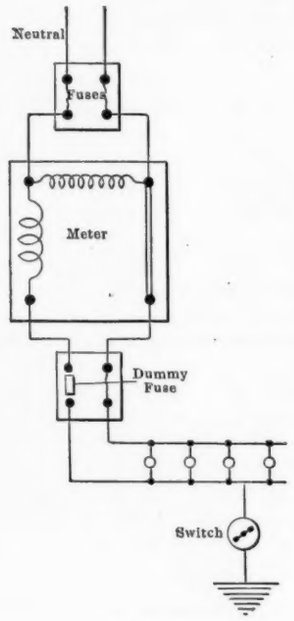


Fig. 1

it is a pretty hard trouble to locate. The customer who resorts to such tricks is usually a shrewd fellow, and he generally switches off the ground and replaces the dummy fuse with a sound one in the daytime.

The method illustrated in Fig. 2 is somewhat similar to the one shown in Fig. 1, the difference being in manner in which meter is connected on service side, which makes it more difficult to steal power, because two dummy fuses have to be used instead of one. In this case the meter does not record because there is no current in the potential circuit.

Fig. 3 shows a method that is used quite frequently when there is a balanced load on a three-wire circuit. A dummy fuse is inserted in the neutral on the street side of the meter, with the result that no current can flow in the potential circuit of the meter, and the instrument therefore cannot record. I have had several cases of this kind where sign lamps were supplied through the meter and the load was therefore normally balanced.

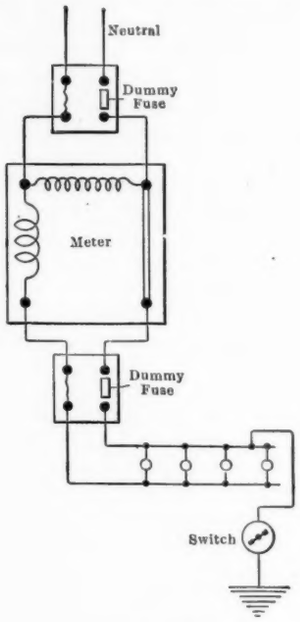


Fig. 2

Fig. 4 shows another method sometimes used in stealing power from a three-wire system. A dummy fuse is placed in the positive line on both the service and the house sides of the meter, as indicated. This cuts the potential circuit of the meter out of circuit, and the meter therefore cannot record when power is being used in the house. To use both sides of the three-wire circuit a "jumper" is put on to connect the two outside wires, as shown at *J*. Of course, this overloads the negative wire, but

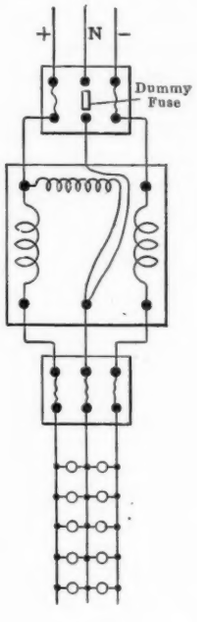


Fig. 3

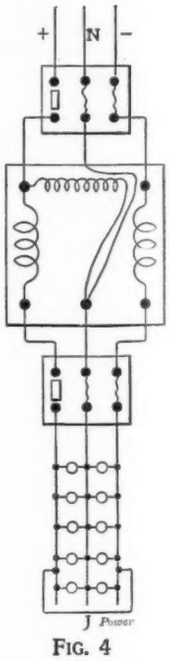


Fig. 4

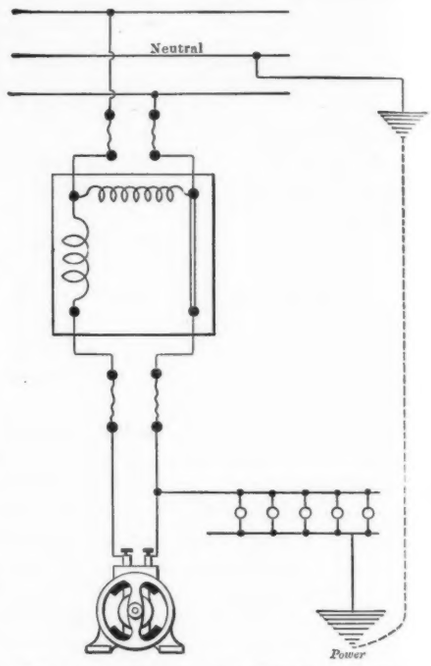


Fig. 5. Stealing Light from a Motor Circuit

what does the consumer care as long as he is getting his power for nothing?

Fig. 5 illustrates the case of a customer who stole current from his motor circuit to supply his lamps. He paid for the motor current and did not tamper with the meter or the fuses. He simply connected a lamp circuit between one of his motor leads and the water pipes, and the ground and grounded neutral of the street mains did the rest.

All of the methods described have been practised on both direct-current and alternating-current circuits, and I have detected them repeatedly in my inspection work. One of the most ingenious schemes for cheating that I have ever come across cannot be illustrated well by a diagram. When the man who installed the meter connected it up he cut the insulation off the wires a little farther back than necessary, which left a little space between the wires and the meter case. The consumer discovered this and put a spider through this space into the meter; the spider spun a web around the disk of meter and stopped it from recording.

[We are inclined to doubt the correctness of Mr. Howard's theory about the spider. It is much more probable that the insect entered the meter voluntarily, in search of dark, warm quarters.—EDITOR.]

National Electric Light Convention

The thirty-third convention of the National Electric Light Association held at St. Louis, was practically opened at 8 p.m. May 23, by a reception on the stage of the Coliseum, followed by a dance. It is becoming monotonous to say each year: "This was the most successful convention in the history of the association," but when that is true, year after year, what else is left for the reporter to say?

The formal opening of the convention occurred Tuesday morning, May 24, when the usual address of welcome by the mayor of the convention city was delivered, the president of the association read his annual address, and various committee reports were presented. The reading of papers began Tuesday afternoon, and from that time until Friday noon papers were so thick that they could almost be pulled out of the air, like the magician's coins, anywhere in the Coliseum. Relatively few of the papers come within the logical field of POWER, the large majority relating to illumination, accounting, and other features of central-station work not included in plant equipment and operation. Those that relate to the latter are abstracted herewith, excepting two gas-power papers which have been transferred to that department.

DERIVING THE NEUTRAL FOR DIRECT-CURRENT THREE-WIRE SYSTEMS

In a paper of this title, James R. Werth, Jr., described in a general way the application of autotransformers and of motor-generators for obtaining three-wire distribution of the current produced by a single generator, as well as the less familiar auxiliary winding on a generator armature. The paper was surprisingly elementary for presentation to men whose lives have been spent in electric-light and power work, describing as it did nothing whatever that is new. All of the methods described in Mr. Werth's paper have been explained in full detail in articles by Cecil P. Poole and R. H. Williams, published in POWER at intervals during the past two years.

Mr. Werth pointed out that balancer sets, consisting of two similar machines with armatures rigidly coupled, are rated by the maximum current that is expected to flow in the neutral, and are built with some margin to take care of the losses in the machines. Thus, if the maximum neutral current is to be 100 amperes, the set would be called a 100-ampere balancer, but each of the two machines would have a capacity of about 57 amperes instead of 50. Referring to the application of intermediate poles, Mr. Werth said that the improvement in operating characteristics due to the use of these is especially noticeable in three-wire balancers because they obviate the necessity of shifting brushes when the motor and generator functions of the two machines are transposed. Without the interpole construction, he said, in order to secure the full output from the machines it is necessary to shift the brushes not only for changes from the motor to the generator condition, but also for changes in the load. If the operating conditions were such as to render it impracticable to shift the brushes for these changes, it was customary to leave the brushes on the neutral and consequently reduce the permissible output of the set 25 per cent. [This will probably surprise those who are accustomed to operate even large machines with fixed brushes from no load to 25 per cent. overload.—ED.]

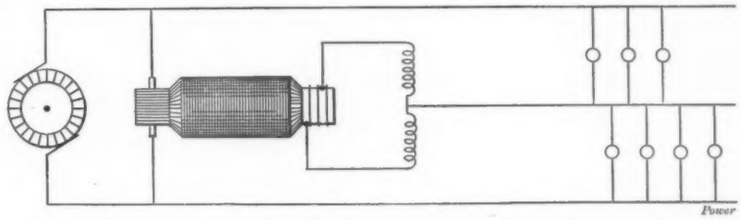


FIG. 1. THREE-WIRE DISTRIBUTION FROM A ROTARY CONVERTER AND AUTOTRANSFORMER

Fig. 1 is a diagram of a method of using an inverted rotary converter, with an autotransformer, for obtaining the neutral connection. The author presented it merely as a possible method and pointed out that it is seldom used and has the disadvantage of not affording means for adjusting the voltages between the neutral and the outer conductors. [He might also have pointed out that it involved a use-less interposition of an extra machine between the generator and the autotransformer.]

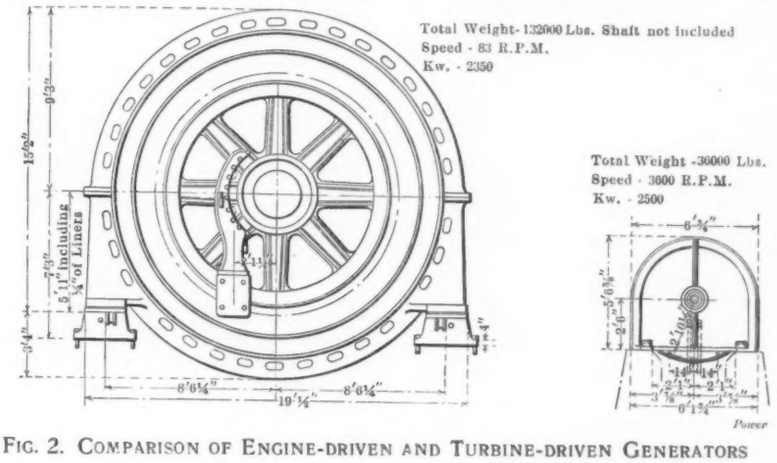


FIG. 2. COMPARISON OF ENGINE-DRIVEN AND TURBINE-DRIVEN GENERATORS

The accompanying table was presented as giving a comparison of weights, effi-

ciencies, floor spaces and costs of the three systems commonly used.

SPACE ECONOMY OF THE STEAM TURBINE

Under the above title Paul M. Lincoln presented a paper which came very near being a partisan brief for the turbine. For a comparison of sizes the sketch, Fig. 2, was shown, together with the now well known picture of a horizontal turbine superposed on an outline drawing of a Manhattan-type engine, which was first published on the front cover of POWER years ago. [Mr. Lincoln inadvertently omitted this latter information.] The diagram, Fig. 2, shows an end elevation of a 2350-kilovolt-ampere engine-driven generator to run at 83 revolutions per minute and an end outline of a 2500-kilovolt-ampere turbine-generator built for 3600 revolutions per minute.

COMPARISON OF APPARATUS FOR PROVIDING THREE-WIRE DIRECT CURRENT SUPPLY.

GENERATORS WITHOUT BASE, SHAFT OR BEARINGS, BUT WITH RHEOSTATS. FOR DIRECT CONNECTION TO HIGH-SPEED ENGINES.

		Two-wire Generator with Motor Balancer.	Three-wire Generator with Compensator.	Two 125-volt Generators Each of One-half the TotalCapacity.
Weight per kilowatt of generating equipment	50 kw.	87.00 lb.	+3.4%	+10%
	100 kw.	78.40 lb.	+4.0%	+ 0%
	150 kw.	91.5 lb.	+2.0%	—20%
	200 kw.	82.42 lb.	+2.1	—12.5%
Efficiency full load; no current in neutral	50 kw.	89%	90.5%	87.5%
	100 kw.	90%	91.25%	90.%
	150 kw.	90.5%	91.5%	90.5%
	200 kw.	90.5%	91.5%	90.75%
Floor space of generating equipment	50 kw.	15.35 sq.ft.	—10.%	+13.%
	100 kw.	20.40 sq.ft.	+1.%	+16.%
	150 kw.	28.50 sq.ft.	+4.5%	+2.5%
	200 kw.	33.26 sq.ft.	+3.%	+15.%
Size of switchboard panels	50 kw.	20″+24″	20″	20″
	100 kw.	20″+24″	20″	20″
	150 kw.	20″+24″	22″	20″
	200 kw.	20″+24″	20″	20″
Cost per kilowatt, including switchboard 10 per cent. unbalancing	50 kw.	$26.70	—9%	+5%
	100 kw.	18.26	—5.5%	+10%
	150 kw.	19.40	—14.0%	—14.5%
	200 kw.	16.55	—4.5%	—3.5%
Compensation for line drop on heavier side?		Yes	No	Yes
Percentage of rated kilowatts delivered when 10 per cent. unbalanced current is flowing in neutral wire		100%	95%	95%

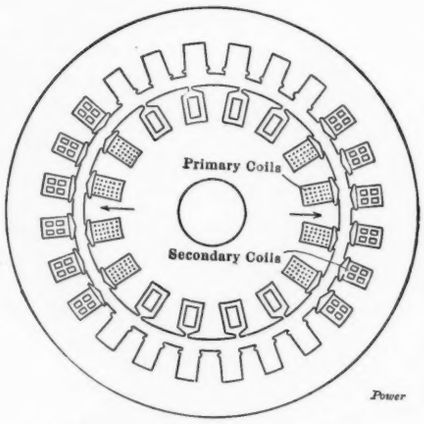


FIG. 3. VARIABLE-INDUCTION VOLTAGE REGULATOR

The pro-turbine arguments of the author were the familiar ones of less floor space, feasibility of putting the turbine in the second story of the station to reduce the ground area of the plant, larger capacity in a single unit, and the possibility in some cases of adding to an existing plant equipment without enlarging the building, when that would be impossible if piston engines were considered.

VOLTAGE REGULATORS FOR ALTERNATING-CURRENT FEEDERS

Two papers were read dealing with automatic voltage regulators for alternating-current circuits, one by E. E. Lehr, discussing the variable-induction type only and the other by F. W. Shackelford, discussing both the variable-induction and the variable-ratio types. The variable-induction regulator is a transformer with its windings on separate cores, one core being movable so as to vary the induction between the primary and the secondary windings. The variable-ratio regulator is the Stillwell form, consisting of a transformer with both windings stationary, and a switch for cutting in and out sections of the secondary winding.

Fig. 3 is a diagrammatic illustration of the variable-induction regulator. The two cores are circular, the primary being an adjustable drum located within the secondary, which is a cylinder much like the stator of an induction motor. This core carries the secondary winding in one-half of its slots, connected up as a bipolar stator would be, while the primary core carries a similar winding. The primary winding on the inner core is connected across the circuit to be regulated, and magnetizes the two cores; the stationary (secondary) winding is connected in series with the circuit and the e.m.f. induced in it by the primary winding either assists or opposes the line e.m.f., and to a widely variable extent, according to the position of the primary core and winding. In the position shown in Fig. 3, the effect is maximum and if the connections are such that the regulator increases the line e.m.f., then by turning the drum away from the position shown, in either direction, the boosting will be gradually decreased until, at 90 degrees from the maximum position, the boosting effect is zero. Turning the drum still further produces a gradually increasing opposition, which becomes maximum when the drum has been turned half a revolution from the position of maximum boosting.

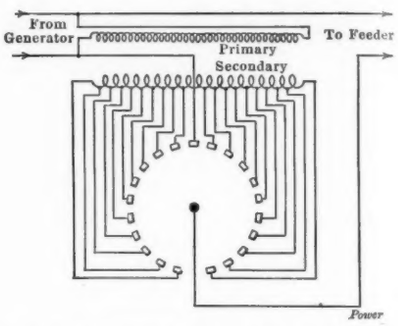


FIG. 4. VARIABLE-RATIO VOLTAGE REGULATOR

Fig. 4 is an elementary diagram of the variable-ratio regulator, which is a modification of the original Stillwell form. The net effect is that which would be obtained if an arm were pivoted in the center and moved around over the contact buttons connected to the secondary winding.

According to Mr. Lehr, the advantages of the variable-induction type of regulator are the absence of contacts upon which burning and arcing occur and which require frequent repairing and replacing; the absence of definite points at which the regulator must stop when raising or lowering the voltage, thus making its action ideal for motor operation or automatic control by means of voltage-regulating relays; the availability of an infinite number of points, giving very close regulation whenever required.

The objections to this type usually given by advocates of the step-by-step type are noisy operation, high magnetizing current, and large inertia of moving element. Careful investigation shows, however, that by properly designing the regulator these objectionable features can be either entirely eliminated or reduced to such an extent as to be no serious disadvantage. The development of noise indicates that the regulator is defective mechanically. With an air gap of uniform length at all points, and the rotor symmetrically placed with respect to the stator, all the magnetic stresses will be

perfectly balanced and there will be no tendency to develop noise.

A great deal has been said about the bad effect of an induction regulator upon the power factor of the circuit on which it is used, but that is not a very serious matter. Regulators are usually wound for 10 per cent. regulation; the kilowatt capacity of the regulator is, therefore, 10 per cent. of the capacity of the circuit upon which it is used, so that even a very poor power factor for the regulator itself will not greatly affect the circuit as a whole. The power factor of a single-phase regulator will probably vary from 80 to 90 per cent., while in some few cases it may be lower. The efficiency will vary from 90 to 98 per cent., depending upon size and characteristics. The following table shows the effect of placing a 22-kilowatt regulator of the latest design, as described, on a circuit of varying power factor. The results are computed from complete data with the regulator in the position of maximum boost and using an efficiency of 94.7 per cent. and a power factor of 82 per cent. These are good average values, and the results obtained will not be materially different for other sizes.

Power-factor of circuit, not including regulator	100	95	90	85	80	75	70
Power-factor of circuit, including regulator	99.8	93.5	88	82.7	77.8	72.8	68.3
Per cent. decrease in power-factor due to regulator	0.2	1.6	2.3	2.7	2.8	2.9	2.5

The characteristics of the variable-induction regulator have been much improved by distributing the windings in several slots instead of using only two, as in the early apparatus. This reduces the self-induction, and therefore raises the power factor, and it also gives a smoother voltage curve.

Mr. Shackleford's paper described the two types impartially and pointed out that the variable-ratio type responded more promptly to the pilot relay because the moving element is a light switch arm having little inertia, whereas the moving core of the variable-induction type is quite heavy; the variable-ratio type could cover its entire range in three or four seconds, and the variable-induction type required about ten seconds. Fig. 5 is a chart from a recording voltmeter, showing the quick action of the switch type of regulator. The upper record shows the fluctuations of the voltage received by a substation and the lower record the corresponding voltage delivered by the same substation to a feeder regulated by the variable-ratio or switch type of apparatus.

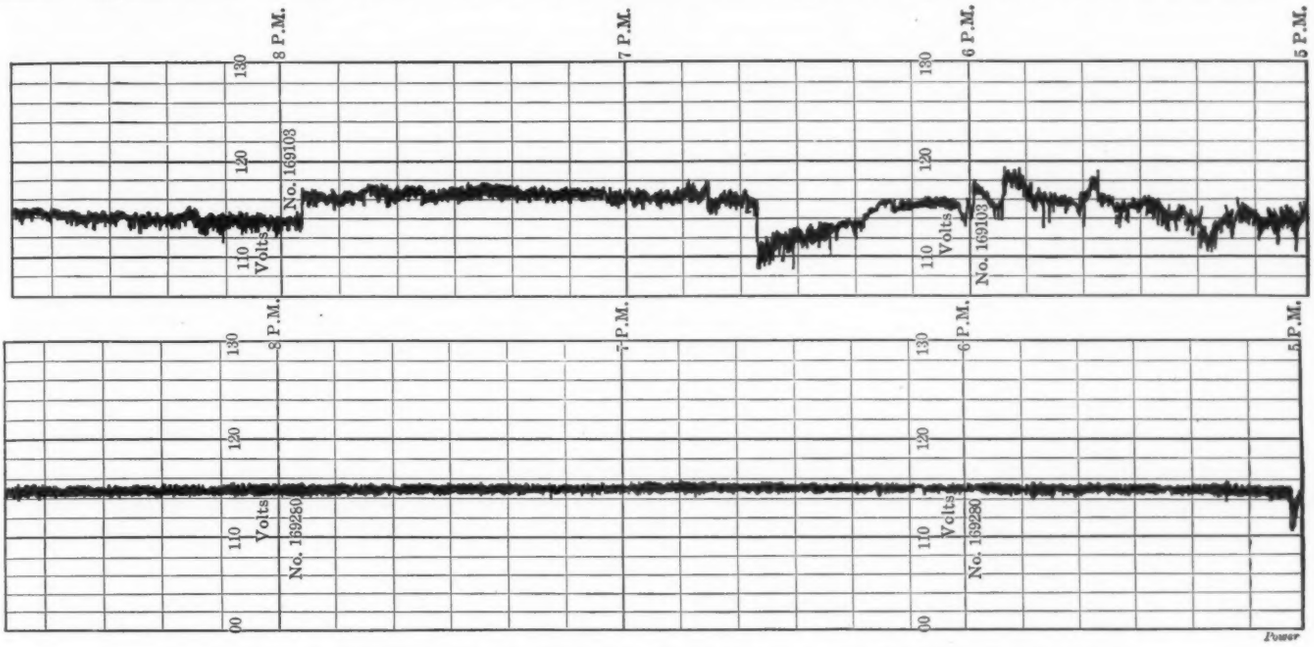


FIG. 5. VOLTMETER RECORDS SHOWING EFFECT OF AUTOMATIC VOLTAGE REGULATOR

SOME PROBLEMS IN POWER TRANSMISSION

was the title of a paper by H. W. Buck, in which the author pointed out that increased length of span on transmission lines has been a natural result of the introduction of steel towers. It reduces the number of insulators and consequently the opportunity for breakdowns, and has other advantages, but the lengthening of the span has introduced other difficulties.

With the old-fashioned short-span construction common on wooden pole lines the questions of sag and strength of conductor were of very little importance. Lines could be installed slack, using soft-drawn conductors and strains on insulators and supports could be reduced to a minimum. Conductors on this account seldom broke. The sag was small in any case, and a foot or so more or less made very little difference. With long spans, however, there is a radical difference in requirements. In order to reduce the hight of towers, since their cost increases almost as the square of the hight, the conductor must be drawn up to the maximum possible tension. This has eliminated the use of soft-drawn metal for conductors and has necessitated the development of commercial hard-drawn copper and aluminum of very high elastic limit. The long span also requires the stringing of the wire with the greatest care with accurate observations as to temperature and tension.

The economical span length for steel construction under present conditions ranges from about 300 feet as a minimum to 750 feet maximum, depending upon a large variety of conditions peculiar to each line.

INSULATORS

Up to about 60,000 volts the standard type of pin-insulator construction gives very satisfactory results. With the rise in transmission voltage above this figure, however, mechanical difficulties are encountered due to the large size of pin insulator required.

Probably the most important and radical improvement which has taken place in recent years in power transmission has been the development of the suspension insulator. It superseded the pin type almost immediately for the very high voltage lines and now is standard for voltages above about 80,000. The 100,000-volt lines recently built, with suspension insulators, have actually given less in-

sulator trouble than the early 20,000-volt lines did when they were first installed. The insulation resistance with suspension insulators can be increased to almost any desired degree.

Regulation

Voltage regulation under variable load on very long high-voltage lines cannot be considered satisfactory under present conditions. This is due principally to the great inductive drop and the excessive charging current, both of which are exaggerated at 60 cycles. For instance, the wattless leading current in a 100,000-volt, 60-cycle, single-circuit line 150 miles in length is approximately 50 amperes, or 8650 kilovolt-amperes. This requires a very considerable generator capacity to charge the line even at no load. This charging current magnetizes the generator field so that the voltage automatically builds itself up until a condition of high saturation in the generators is reached. In order, therefore, to maintain normal voltage under these conditions the generator field excitation must be cut out almost entirely. The combination is highly unstable. As the load comes on, if it is inductive, such as induction motors, the line-charging current may be neutralized or the power factor may actually show lagging current as a resultant. The generator field excitation must then be strengthened to a point which on the no-load saturation curve of the machines would correspond to a voltage much above normal. Then, if some circuit-breaker on the system should open, cutting off a large block of energy load and also part of the compensating lagging current, the resultant current at the generators immediately changes from lagging to leading, the line-charging current again predominating, and the generator voltage may rise as much as 50 per cent. This serious rise in voltage is caused by momentary speed rise due to reduction in load, armature reaction due to change from lag to lead, and in addition there is the boost of voltage over the line inductance due to the leading current. Other power users on the system which remain connected to the lines under these conditions will suffer from the disturbance.

This problem in regulation can be solved only by the installation of shunt inductances permanently connected at intervals along the line and so adjusted as to neutralize the line-charging current, regardless of conditions in the various receiver circuits. If it becomes necessary to neutralize the lagging currents of the receiver circuits, rotary condensers should be installed. It is not feasible, however, to neutralize the lagging currents in the receiver circuits with the line-charging current because the former vary and the latter is constant.

Reliability of Service

As long as overhead transmission lines exist as they are under the present state of the art, occasional interruptions to service will necessarily occur. It is better to recognize this and make provision to reduce the duration of interruption. The real problem in satisfactory service is to design switching arrangements and provide spare circuits and apparatus so that when trouble does occur it can be located rapidly, cut out and service resumed at once. Resumption of service should never wait upon repairs.

One of the most important elements in case of trouble is effective telephonic communication between the various parts of the transmission system. The practice lately has been to remove telephone wires entirely from transmission towers, so that they will not be subject to trouble from the high-tension conductors. This is especially necessary on the very high-voltage lines because of static induction, which is more difficult to eliminate than magnetic induction; this can usually be overcome by transposition.

CONSTRUCTION AND OPERATION OF HIGH-TENSION TRANSFORMERS

A paper of the above title was presented by K. C. Randall, who described the different forms of construction and methods of insulation commonly embodied in the transformers under discussion, and pointed out the limitations and advantages of each. Referring to the question of interchangeability, the author said it was unfortunate that exact duplicates of old apparatus, rather than electrically equivalent units, should be so frequently insisted upon, because in so doing it is impossible to take advantage of any progress in the art made since building the original apparatus. There is a distinct difference in the physical proportions, in the ruggedness and strength, and some differences in the electrical characteristics, of new and old transformers. It probably would be well for a purchaser to state his conditions, saying that duplicate units are desirable, or better yet, that electrical equivalents are wanted. Then the designer will know the conditions and will be in a position to offer the best solution for them.

The proper way of determining transformer temperatures is by the use of both thermometers and the change in resistance method. Insulating materials for high-voltage work should not be operated at temperatures beyond 90 degrees Centigrade, and preferably not more than 80 degrees Centigrade, as at about 100 degrees deterioration sets in and continues gradually, and at higher temperatures it progresses rapidly.

To determine whether transformers will operate satisfactorily only a simple voltage-drop test is necessary. Take two transformers of equal ratios and capacities, connect the low-voltage windings in series and short-circuit the high-tension windings. Connect the low-voltage windings, in series, to a low-voltage circuit and measure the voltage across the terminals of each winding; if the two voltages are equal or nearly so (within 10 per cent.) the two transformers will operate in parallel and divide the load satisfactorily.

The essential point in the care for transformers is cleanliness. The ordinary load and temperature logs will be of great assistance in indicating what attention the transformers may need. Occasional thorough inspection and overhauling is important. At these times, the cooling coils, windings, terminals, pressure blocks and outlet bushings should be carefully gone over and cleaned, and pressure blocks tightened.

Periodical tests should be made of the oil to see that no moisture accumulates during operation. The advantage of such tests is evidenced by the following incident. An operating superintendent was startled by hearing a tapping sound like a small hammer inside of a 60,000-volt unit of large capacity. A casual inspection revealed nothing to cause the noise. A test was then made of some oil taken from the top of the case, which showed the presence of moisture. A sample drawn from the bottom of the case was then tested and found to be partly water. In short, several gallons of water were immediately withdrawn and for several days thereafter a gradually decreasing amount was removed until the samples were quite free from water. Regular tests are now made at this installation to detect the presence of moisture. The tapping sounds were discharges through the oil to the tank and occurred at times of switching on the line. None of the several units were damaged, although all of them contained more or less water which accumulated by "breathing" through an open vent pipe.

The following instance will illustrate how easily wrong impressions originate as to the condition of insulation: A 60,000-volt transformer was under test and the insulation would not hold. Several duplicate transformers stood the test and so an investigation was made. A potential of 50,000 volts was impressed between the high-tension and low-tension windings and core; it held for only fifteen seconds, and several air bubbles rose to the surface of the oil. The tank, being round bottomed, was rocked slightly and the voltage again applied and increased to 60,000, at which point the insulation again broke down. More bubbles were seen and again the tank was rocked—this time it held up at 60,000 but broke at less than 75,000 volts. The process was continued and at each application the insulation held up at about 10,000 volts higher than the previous one. Finally, after several trials, the insulation held for more than one minute at 120,000 volts with no trouble whatever.

Gas Power Department

Gas Power and Central Station*

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

The Gas Engine Committee of the National Electric Light Association, which has previously devoted its attention chiefly to large gas-power installations, applied its efforts during the past year to the smaller plants, running on natural gas, illuminating gas and producer gas, with a view to investigating the effect of such plants upon central-station business. To this end, inquiries were sent to all electric-lighting companies in towns of 5000 population and over. Table 1 gives the general results.

The committee corresponded with a number of owners of isolated or industrial plants of about 100 kilowatts and under; the replies are summarized in Table 2. About 40 per cent. reported dissatisfaction of one kind or another, but practically none of them were able to give unit costs.

TABLE 1. SUMMARY OF CORRESPONDENCE WITH MEMBER COMPANIES.

	New England States.	Middle and Southern States.	Western States.	Total.
Number of companies written to	39	54	113	206
Number of companies replying	37	31	56	124
Number of companies failing to reply	2	23	57	82
Number of companies sending data	4	5	12	22
Number of companies replying that they have no gas engine competition	16	16	33	65
Number of companies reporting 1 to 3 engines in their territory, but no competition	10	4	11	25
Number of companies reporting that they have over 3 gas engines in their territory and competition	3	2	1	6

In its annual report to the convention held at St. Louis, May 22 to 27, the committee points out that the figures in Table 1 do not agree with reports made by manufacturers of gas engines and gas producers, and expresses the belief that this apparent discrepancy is explained by the fact that many of the installations which the manufacturers reported are located away from central-station companies' lines, and that the amount and character of the business would not justify the cost of extending these lines to such installations. It is still felt that, in some instances, the member companies are not fully informed.

The correspondence has brought out the fact that there are many more gas engines scattered around the country, which are run by illuminating or natural gas, supplying power to line shafting or direct to power-consuming apparatus than there are driving electric generators. Detail operating costs on such engines could not be obtained because of the difficulty of accurately determining the power developed for any extended period of time. In many cases, these installations do not disturb the electric-light company, either because the location is such that the business would not warrant the expense of reaching it, or because the requirements are so intermittent or unusual that the business would not be profitable to the central station.

*Report presented at the St. Louis convention of the National Electric Light Association.

TABLE 2. SUMMARY OF CORRESPONDENCE WITH OWNERS OF GAS POWER PLANTS OF ABOUT 100 KILOWATTS AND UNDER.

	New England States.	Middle and Southern States.	Western States.	Total.
Number of owners written to	28	32	28	88
Number of replies received	16	19	12	47
Number who failed to answer	12	13	16	41
Number of replies received stating plant is satisfactory	13	11	4	28
Number of replies received stating plant *not* satisfactory	..	3	3	6
Number of replies stating engine is satisfactory, but either not mentioning the producer or stating producer is not satisfactory	..	2	2	4
Number of replies received stating indifferent or poor results	3	3	3	9

The committee corresponded with the leading builders of gas engines and producers in order to learn what changes, if any, have been made in their apparatus since the former reports. Without exception, all of them state that they are steadily making improvements which tend to increased reliability and in many cases to better efficiency. Experience has shown where engine parts could be lightened, either because they were unnecessarily heavy, or by the use of higher grade materials. It would seem, therefore, that while general improvement is being made in many details, there has been no radical change in design during the past year.

Referring to the situation which has recently developed in the Southwestern and Northwestern States in the utilization of lignite fuels, which heretofore have been practically unsuitable for power development when used for steam generation, the committee reports that the application of the gas producers has enabled them to be used with great economy; the reports of the United States Government and of gas-engine builders indicate that within recent years many practical and satisfactory gas-power installations have been made and are now operating on these low-grade fuels.

Early in March of this year the committee visited the Gary plant of the Steel Corporation. At that time both power plants (electric and blowing units) were running well and the people in charge seemed well pleased with the apparatus. The gas engines are remarkably free from back firing and premature explosions. This is due largely to the very efficient gas-cleaning apparatus, and the gas was apparently much cleaner than the air supplied to the engines. The switchboard instruments indicated some cross currents between units, but this, apparently, is not prohibitive.

Since starting the electric plant, some modifications have been made in the piston rings, piston-rod packing and the circulation of cooling water; but apparently there has been no indication of any serious error in design or construction. Some difficulties have been experienced, but most of them were of a minor nature and are being corrected. On the whole, the service rendered, from the viewpoint of reliability, has been satisfactory, as far as the committee could ascertain. For obvious reasons, no statement can be made of the fixed charges or of the operating costs of this notable installation.

After last year's report appeared in print, it was discovered that in printing or proofreading some serious errors had accidentally crept into some of the lists of gas-engine and producer installations made by various manufacturers. In some instances, installations made by one manufacturer were credited to another manu-

facturer, and in other instances the lists of installations were not complete. The present committee, in order to correct the injustice unfortunately done, requested all the manufacturers whose lists were published last year to submit corrected lists. The responses were incorporated in corrected lists appended to the report. [These lists are too voluminous to reprint here.]

In conclusion, the committee reported that statements from the electric-light companies which replied to the inquiry indicate very little serious competition between central-station service and the gas-engine outfit run on illuminating or natural gas. This appears to be partly due to the efficient work of the sales departments of the various member companies, and also to the fact that the high cost per kilowatt-hour of such gas makes the cost of gas power so high that most prospective customers would prefer to buy current from the central-station company, and, in addition, to be relieved of the care and annoyance of the gas-engine plant.

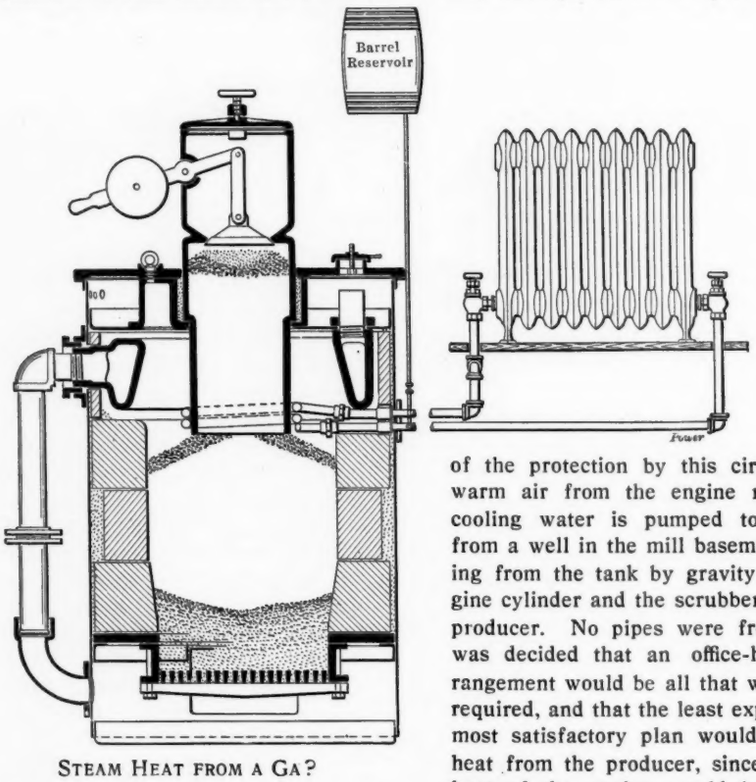
The Gas Engine Committee for the past year consisted of I. E. Moultrop, chairman; C. A. Graves, P. Junkersfeld and J. B. Klumpp.

Simple Adaptation of a Gas Producer for Heating

By Frank P. Peterson

The development of means for the application of heat from a gas producer to factory heating lies along lines so simple that it is surprising that more has not been done in this direction. An interesting little arrangement of this sort has been devised by Chas. E. Darrow, proprietor of the Conneaut Lake Roller Mills, Conneaut Lake, Penn., and put into service in connection with his producer-gas plant. The installation of the gas-power plant was made late in the summer of last year, and in the confusion incidental to the removal of the old plant and substitution of the gas plant, and also to the pressing demands of the season, provision for the heating obviously to be required was allowed to go over until cool weather came as a reminder that some provision must be made to meet the exigencies of the approaching winter. With the old plant, the required amount of live steam had been taken from the boiler to supply the heating system.

The first suggestion, naturally, was to locate a small boiler in the producer room, which is a lean-to at the southeast end of the mill. The producer-room floor is about 10 feet below the main mill and office-floor level, and the office is also a lean-to structure, with the floor about 6 feet from the ground and an open space beneath. A door opening onto a stairway leads from the main mill floor down to the producer-room floor, and it was found before placing the heating connection that the mill remained comfortable enough for the operators to work by leaving this door open. Also a galvanized water tank 7 feet diameter by 3 feet deep passed through a snap reaching 4 degrees below zero, Fahrenheit, and showed a film of ice only half way across its surface, because of the protection by this circulation of warm air from the engine room. The cooling water is pumped to this tank from a well in the mill basement, returning from the tank by gravity to the engine cylinder and the scrubber of the gas producer. No pipes were frozen; so it was decided that an office-heating arrangement would be all that was actually required, and that the least expensive and most satisfactory plan would be to use heat from the producer, since the waste heat of the engine would be available only while it was in operation.



Steam Heat from a Ga?

The owner of the mill decided to try a simple hot-water coil located within the producer fuel chamber, and the arrangement was developed as shown in the accompanying drawing, which shows a vertical section of the producer generator. From a barrel located near the roof in the corner of the producer room, water is supplied to the coil through a ⅜-inch pipe. This arrangement became absolutely automatic, and for the season's service required no attention whatever beyond an occasional replenishing of the water in the barrel to make up for the slight evaporation.

The circulation is quite active and regular, and, although the office room has three large windows and only one radiator of 16 square feet of surface, the room was kept entirely comfortable on the coldest days, and the service seemed to be almost the same with the producer standing idle as when it was in service.

The coil is of 1¼-inch black iron pipe and the outlet reduces to 1 inch on leaving the producer shell. Magnesia covering is provided on the outgoing line, but the return line is not covered. Valves are provided for cutting the radiator out during the warm months.

The Rating of Gas Producers

By J. A. Carruthers

Some time ago, while away on a business trip, it was part of my duty to look into the operation of two different plants in which were installed suction gas producers and engines. The fuel used in each plant was Bankhead anthracite coal, and in the one case it gave the best of satisfaction and economy, while in the other there was complaint to the effect that the coal would not furnish sufficient gas to carry the full load more than a few hours without cleaning out the producer. In the latter plant, which I will call No. 2, the coal used was pea size of the usual grade up till such time that the operating department became sure that the plant could not carry the load of 500 horsepower continuously (that is to say, 12 to 18 hours), and so the next larger size, nut, was used thereafter. There was still trouble with even this size, the producer having to be entirely cleaned out and started fresh every day. This could be done without interfering, because there was no day load on the generator, but it soon resulted in a large pile of half-burned coal mixed with ashes. In this plant the producer was charged before the load came on with about 2000 to 2200 pounds of coal, and was not barred down at intervals during the run. Naturally, it bridged and gave anything but satisfaction.

Plant No. 1, which operated satisfactorily, consisted of two engines of 150 horsepower each, supplied by two producers rated at 200 horsepower each,

while plant No. 2 had one twin-cylinder engine of 500 horsepower and a producer rated also at 500 horsepower. The operation of plant No. 1 differed from that of No. 2 in that it ran night and day except Sundays, and the charging was done in quantities of 330 pounds to each producer as required, and the fuel beds were kept barred and worked down to prevent forming air flues. A little trouble was experienced with tar clogging the engine valves at first, but this was overcome by the engineer putting in a second tar extractor in parallel so that he could clean one at a time without shutting down; as there is very little tar in this class of coal he was enabled to get continuous operation.

Practically the entire trouble at plant No. 2, however, was due to an overrated producer. Below is a comparison of the dimensions of the producers in the two plants, which shows that the engineer of No. 2 was certainly "up against it."

	Plant No. 1.	Plant No. 2.
Rated engine horsepower....	300	500
Rated producer horsepower....	400	500
Outside diameter of generator shell.....	6 ft. 6 in. (each)	5 ft. 2 in.
Inside diameter of generator lining	4 ft. 6 in. (each)	3 ft. 2 in.
Inside depth of fuel chamber...	6 ft. 6 in. (each)	5 ft. 8 in.
Total available volume.....	208 cu.ft. (both)	50 cu.ft.

As regards economy of operation in No. 1 plant, the engineer assured me that for about a week or ten days, during which he paid particular attention to the weights and timing of charges, the engines were developing their rated power on a coal consumption of 1.4 to 1.5 pounds per horsepower-hour. Any plant that can get under the two-pound rate ought to make the average steam engineer sit up and take notice, if the results are obtained under ordinary running conditions.

CORRESPONDENCE

Steam and Gas Power Fuel Economy

In an editorial in the April 26 number, in discussing Mr. Ellison's paper, the question is asked, "How many steam plants of 1000 horsepower, or under, are doing, or can do that or anything like it?" That is, yield a brake horsepower-hour with 1¼ pounds of pea or 1½ pounds of bituminous coal.

We have only to search the back numbers of POWER to find a record of such a performance. Recently, in a short notice of an English combined engine and boiler unit, known on the Continent as a "Locomobile," there is recorded a performance of a 70-horsepower unit operating at 55 indicated horsepower and using 1.19 pounds of coal per French brake horsepower-hour, and having a water consumption of 10.66 pounds per brake horsepower-hour. A French horsepower equals 72/75 of an English horsepower. The steam was superheated 158 degrees by the waste gases from the boiler. The efficiency of the boiler with its superheater was 75 per cent.; of the heat in the fuel, which contained 14,260 B.t.u. per pound, 10,695 B.t.u. were taken up by the boiler and superheater. Of this heat the engine delivered in useful work at the wheel 19.9 per cent., or 14.95 per cent. of the total heat in the coal.

In Germany, by means of a secondary superheating of the steam between the high- and low-pressure cylinders, the efficiency of the boiler and engine have both been increased. One case is reported of a 100-horsepower unit, where 1.08 pounds of coal per brake horsepower-hour, or 17.3 per cent. of the heat in the fuel was used. In another instance 0.89 pound coal per brake horsepower-hour was obtained.

In July, 1906, POWER contained a description of a test on an outfit rated at only 40 horsepower. The coal used per brake horsepower-hour was 1.33 pounds. A comparison of this with later practice shows the progress which has been made in the application and use of superheated steam.

Reports from users of these "Locomobiles" having only one stage of superheating show excellent results. One, in Chile, rated at 80 to 125 horsepower, used 1.76 pounds of coal. The heating capacity of the coal was 11,000 B.t.u.

In Spain, a 110-horsepower unit used 1.57 pounds of coal, the heating capacity of which was 12,960 B.t.u.

In London, there is reported a consumption, in actual service, of 1.54 pounds coal per horsepower. In all of these instances, only one stage of superheating is used. Better results are now secured by secondary superheaters.

The above shows that steam is equal to or ahead of gas in economy in moderate-size units. Reliability and durability, also the independence of the user in the choice of fuels, are all in favor of these steam engines whereas the small range of economical load, the narrow field in the choice of fuel with gas-producer plants are well known.

The depreciation of a plant with a boiler and its steam engine is much less than that of a gas producer and its gas engine.

J. B. STANUM.

Cincinnati, O.

[We have heard many and published some reports of the remarkable fuel economies obtained with the semi-portable type of steam engine and boiler in Europe. It is a significant fact, however, that these outfits have not been introduced into the American industrial field, despite the widespread publication of their performances. It is also true that in Europe, where these high fuel-economy records have been made, producer-gas plants have also shown fuel economies never attained in this country. It is not the best of logic to compare American gas-power figures with European steam-power figures. If we wished to use this method at the expense of impartiality, it would only be necessary to compare European gas-power figures with American steam-power figures to "prove" that the steam engine is "doomed"—which, of course, would be utterly absurd.

Mr. Stanum's argument as to fuel restrictions, reliability and maintenance is justified; we have repeatedly pointed out the same facts. But his contention as to "small range of economical load" is on the wrong side of the fence.—EDITOR.]

What Broke the Cylinders Off?

A few days since there was an odd sort of an accident in an engine room here. The equipment is a three-cylinder vertical gas engine, with cylinders of 8 inches bore and 10 inches stroke, driving an electric generator for lighting the buildings, charging a storage battery and furnishing power to run the laundry. The engine has been running for about six years and has been kept in good repair.

At the time of the accident the engineer, who is a careful and experienced man, was out of the room. Suddenly the engine began to slow down and then stopped. When the engineer reached the engine room he found the two outside cylinders torn off from their flanges just above the fillets. The metal at this place is 1⅛ inches thick, and the flange is bolted to the crank case by eight 1-inch studs. The middle cylinder is intact. The various pipes and connections were broken, but the connecting rods and pistons were not at all injured nor were the snap rings cracked; the crank shaft was also uninjured.

Now, what caused this wreckage? No one hereabout can give any "reason" that seems reasonable. It has been suggested that the water supply was responsible for the trouble, but if that is so, why should the middle cylinder escape? The cooling water is taken from the city mains at a pressure of 30 pounds, and passes through the jackets "in parallel," by individual inlets and outlets, the hot water passing into a tight tank of some 15 barrels capacity, from which is supplied hot water to the kitchens, etc. This has been in use for several years and has been very satisfactory.

CLARENCE STERLING.

Bridgeport, Conn.

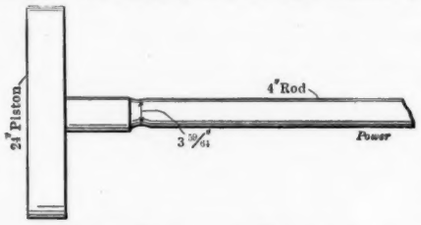
Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

Too Much Compression

In taking down for inspection, the high-pressure side of a 24 and 42 by 36-inch cross-compound Buckeye engine we found that the piston rod had a shoulder worn as shown in the accompanying sketch. Holmes metallic packing was used on this rod and the engine had been in continuous service for three seasons without a thorough inspection. The packing was in good condition except the end ring, which was somewhat rounded from the effect of the shoulder on the rod.

No indicator had been used on this engine for two years, and the only plausible reason we could give for this condition



PISTON ROD WITH SHOULDER

was that the compression at the crank end of the stroke was too high owing to too early closure of the exhaust port. This condition would cause the packing rings to grip the rod so hard as to produce undue friction, with resulting wear as shown.

We put in a new piston rod and when the engine was again in commission we took some indicator diagrams and found that the compression at the crank end was too high as had been suspected. The valves were readjusted and no more trouble from that source has been experienced.

C. D. ELDREDGE.

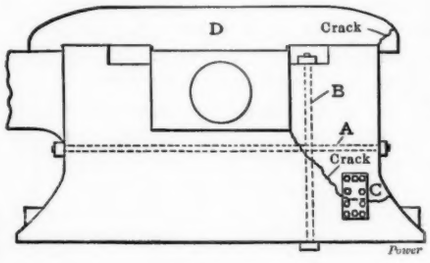
Fairport Harbor, O.

Reparing a Broken Main Bearing

Some time ago a wreck occurred in connection with our Corliss engine and one of the worst breaks was the splitting off of the back end of the main bearing, which caused us to put our heads together, in order to get the engine running again as soon as possible.

The engine is a single-eccentric 18x42-inch Corliss, running at 73 revolutions per minute and furnishing power for a 60-ton cotton-seed oil mill and fertilizer plant combined. The piston was of the regular built-up type with sectional packing, bull ring and follower plate bolted on. One of these bolts was the primary cause of the wreck; having become crystalized, it broke off and dropped down into the cylinder and on the return stroke smashed the follower plate. On the next stroke a piece of the broken follower plate got between the piston and the front head of the cylinder, and as this proved to be stronger than the back end of the main bearing the latter gave way as shown in the illustration. A small piece of the packing then dropped down into the exhaust port, blocking one of the exhaust valves and cracking the wrist-plate.

We soon figured out how we could repair everything but the main bearing and this had us guessing for a while, but we finally decided on the following arrangement to pull us through until the end of the season when we could get a new frame for the engine. We replaced the broken pieces as shown, and drilled two horizontal holes through the frame and into these put two 1½-inch bolts *A*. Next we drilled two vertical holes from the recesses at the top of the bearing, through to the bottom of the frame and into these inserted two 1½-inch bolts *B*.



METHOD OF REPAIRING BEARING

By taking up on the bolts we brought the broken section firmly into place. We then put the patch of ⅝-inch boiler steel *C* on both sides of the bearing and bolted them on with ¾-inch cap screws. A new cap 1 inch thicker all around was cast to replace the broken cap *D*.

The repair stood up so well under full load that we decided to let well enough alone, and have run another season with it.

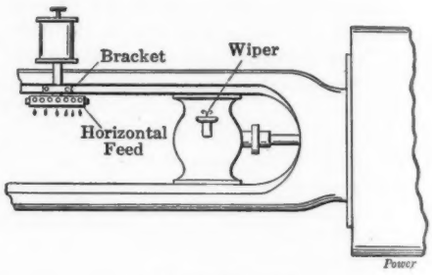
H. E. WILSON.

El Dorado, Ark.

Device for Saving Oil

The original method for oiling the crosshead pin on our engine consisted of an oil cup carried on a bracket fastened to the upper guide. There was but a single feed from the oil cup and when a greater feed was needed to keep the pin cool the number of drops was increased, but this meant a decided waste of oil while the crosshead was near the ends of the stroke.

To remedy this I devised the scheme shown in the illustration. Attached to



OILING DEVICE

the vertical feed is a piece of brass pipe about 6 inches long, with a number of ⅛-inch holes drilled along the top. The ends are tapped and plugs inserted, this being merely to facilitate cleaning should the oil become thick and clog up the pipe.

The oil from the cup feeds into this horizontal pipe, overflows through the holes at the top and creeps to the bottom. Instead of the crosshead pin getting one drop per stroke as with the old arrangement, the wiper will now take up several drops which cling to the bottom of the horizontal pipe. This device can be regulated so that no oil at all is wasted and yet have the pin receive ample lubrication. Care should be taken to set the horizontal pipe exactly level, or the oil will all run toward one end.

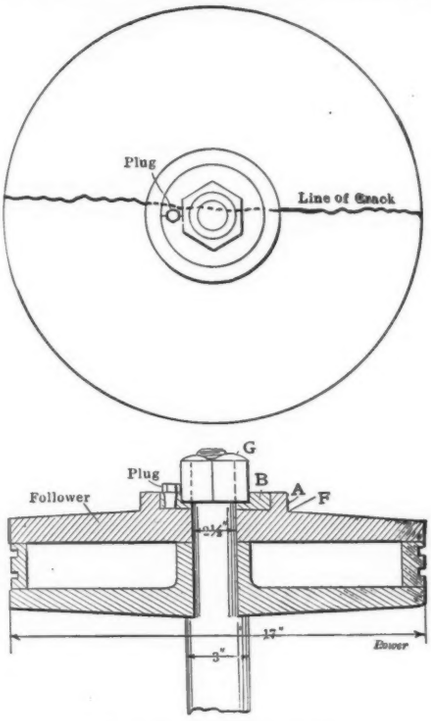
W. A. DOW.

Cambridge, Mass.

An Unexplained Break

In a power plant recently visited by the writer, there is installed a 17 and 36 by 36-inch vertical cross-compound McIntosh, Seymour engine, direct-connected to a 400-kilowatt alternating-current generator, the latter being placed on the shaft between the cranks of the high- and the low-pressure cylinders. The engine had been operating satisfactorily for about five years, running at 120 revolutions per minute under 150 pounds steam with every little variation in either the pressure or load.

A surface condenser of ample capacity is located in a rib about 14 feet below the exhaust outlet of the low-pressure cylinder and connected to it by a 16-inch exhaust pipe. An 8-inch centrifugal circulating pump supplies salt water at a temperature of about 55 degrees Fahrenheit. The air pump is of the direct-acting



PISTON AND FOLLOWER

type, delivering the water of condensation into a hot-water tank about 20 feet above the pump foundation and maintains a vacuum of from 25 to 26 inches.

Soon after starting the engine one night a few weeks ago, the engineer heard an unusual sound which seemed to come from the high-pressure cylinder. Thinking that perhaps it was due to a little water in the cylinder, and as the noise did not increase and there was no jar or pound accompanying it, he went about his other duties and did not return to the engine for some time. The oiler then reported a click in the cylinder, whereupon the engineer made a thorough examination of the cylinder and valve gear, the noise continuing all the time but not increasing in intensity. It seemed to emanate from the upper steam-valve chest. After failing to discover the cause, the engineer wisely concluded that the safest course was to stop the engine and then if possible ascertain the cause. He accordingly cut in another unit of the same capacity and stopped the former.

Upon removing the high-pressure cylinder head he discovered that the follower on the piston was broken as shown in the illustration, and also found in a pocket of the steam-valve chest a number of pieces of cast iron which when put together nearly formed the collar *A*. This had been sheared off at the point *F* close to the face of follower. The piston is fitted to the piston rod with a slight taper and, with the follower, is secured by the nut *G;* the latter being locked by the washer B, the inside surface of which is hexagonal to conform to the shape of the nut. The washer is split on one side and at this point is inserted a tapered plug. It will be seen from the sketch that by screwing in the tapered plug, the washer is expanded and impinges on the collar, thus preventing the nut *G* from turning.

There was no evidence of water having been carried into the cylinder and it was seemingly impossible for water to have passed the two traps and one separator on the steam line between the engine and the boilers. The engineer in charge of the plant is still at a loss to account for this singular break, especially as the appearance of the broken parts indicated that the break occurred some days before it was discovered. Possibly some of the readers of POWER can solve the problem, especially the shearing of the collar *A*.

W. A. CLARKE.

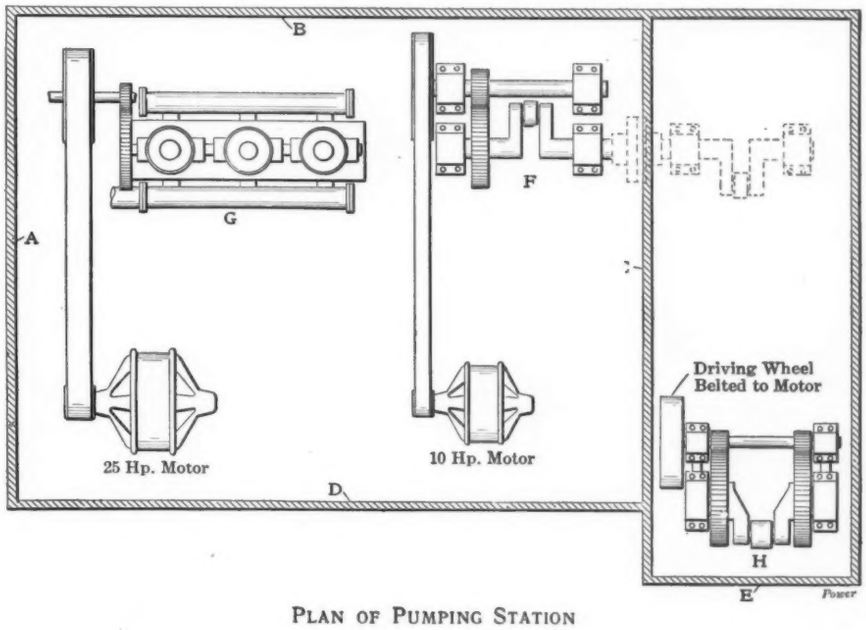
San Diego, Cal.

City Council Engineering

During a short stay in a small town some time ago, I observed alterations going on about the city pumping station and as I was at the time engaged in putting in a pumping station of a similar size, I took more than a passing interest in the work. I introduced myself to the superintendent, who proved to be very well posted but not wholly in sympathy with the present improvements.

They had just completed the installation of a new deep-well pump and were making ready to build an addition to the building, in order to properly house it. The plan of the station is shown in the accompanying sketch. The lines of the original walls were as shown at *A, B, C* and *D*. A single-acting deep-well pump *F*, driven by a 10-horsepower three-phase induction motor, pumps from a 6-inch well into a cistern located at the surface of the ground. In addition to this, there is a triplex pump *G* driven by a 25-horsepower motor. This secures its supply from the same cistern and pumps direct into the standpipe or mains, when direct pressure is required as in cases of fire. This equipment had been in use about three years and gave satisfaction in every way. But owing to the extension of the mains and the natural growth of the system it became necessary to secure more water and here was where the superintendent's trouble began.

His recommendation to the council was to purchase another deep-well pump of the same make as *F* but to omit the driving pulley with its shaft and pinion and to set the new pump directly in line with the old one as shown by the dotted lines. The crank shaft was to be extended to drive the new pump, by the use of a flexible coupling, and the cranks were to be set exactly opposite, which would require the motor to lift but one column of water at a time. This would have necessitated the removal of the wall *C* and an extension of the building. He claimed that the present motor would drive both pumps, or at the worst a motor of not over five horsepower more would be required. A few of the members thought such an arrangement might be reasonable but the fact of the same motor running both pumps, when one pump was a full load, was more than most of them could believe. Since the city was in need of machinery, it was quite natural that men having something to sell should appear before the council. These salesmen ridiculed the idea of one motor being able to operate both pumps, and as a result a contract was closed for a single-



PLAN OF PUMPING STATION

acting deep-well pump *H* to operate an 8-inch well and to be driven by a 25-horse-power motor of the same type as the others.

The committee located the new well by driving a stake just in line with the outside edge of the building and when the pump was placed over the well it necessitated an ell being built on the building and extending out about 6 feet as shown at *E*.

The superintendent had reconciled himself to conditions by this time, but it was hard to see them set the pump outside as far as they did when it could just as well have been set far enough in for an extension of the present walls to cover it. He explained that he had taken the committee down to the station and operated the deep-well pump and shown them the action of the meter; on the up stroke it jumped ahead and on the down stroke it nearly stopped, proving conclusively that practically no work was done on the down stroke, which power he wanted to utilize for the other well.

Another 6-inch well would have been ample and there would have been plenty of time for making repairs between runs. I could not help agreeing with him that his arrangement would have been much preferable and much less in first cost as well as in operation. This is merely an example of such work as is frequently met with, when the employment of a competent engineer would be the best kind of an investment.

G. S. SPRAGUE.

Geneva, Neb.

Second-hand Boilers

A person should be very cautious in buying second-hand boilers, and from experience the writer is convinced that only a certain life should be allowed for any boiler.

Recently, in cutting up some old boilers, the plates were found to snap off like a piece of tool steel, although to all outward appearances they were perfectly sound. An examination of the places at which the shears had been applied revealed a crystallized condition of the steel, the portions which had come in contact with the fire being the most brittle. The flue heads were found to be in a similar condition. Some old steamboat boilers which were made of iron showed a less crystalline appearance, which would indicate that iron plates will stand up better under long usage than steel plates.

It would seem that large return-tubular boilers with their thick plates would be particularly susceptible to such conditions and as a result would have a shorter useful or safe working life. The very fact that the bottoms of the shells were hard and brittle and the top portions more pliable should make us cautious of boilers having seen long service.

Cold-water tests of such boilers might not be proof of their safety, for such pressure may only start a fracture which will gradually work its way through the metal and show failure at some future time. In other words, it is almost impossible to determine the safety of an old boiler unless a piece of the plate be cut out and tested.

C. R. MCGAHEY.

Sheffield, Ala.

System for Treating Hard Water

Having been employed for two years in an electric-lighting and power plant using very hard water in return-tubular and Stirling boilers, my experience may be of interest and value to some other engineers.

The analysis of the feed water was as follows:

Sodium sulphate....	26.0	grains per gallon.
Lime sulphate.....	22.5	grains per gallon.
Magnesia sulphate...	16.5	grains per gallon.
Sodium chloride.....	5.0	grains per gallon.
Total.....	70.0	grains per gallon.

Also a large percentage of free carbonic-acid gas was present.

It was our custom to clean boilers every ten days and we usually found a deposit of very hard scale of from ⅜ to ¾ inch thick. We tried to get the company to put in a water softener of one of the approved types as used by the railways and laundries, but not succeeding in this we made and installed the system shown in the accompanying illustration. Everything used was already in service or had been discarded. We had used a great many kinds of compound but they either allowed the scale to form, caused corrosion, or produced foaming. A local chemist made up a compound to fit our water; this consisted mainly of caustic soda to neutralize the free CO_2, forming soda ash which in turn broke up the $CaSO_4$, forming soluble Na_2SO_4, the insoluble $CaCO_3$ being neutralized.

The compound was dissolved in tank *B*. The supply from the deep-well pump was turned into tank *A* and the injector regulated so that tank *B* would be emptied when tank *A* became full. The ¾-inch line from the injector joins the supply line and the numerous turns produced a thorough mixture. Upon first filling the tank, the water was very milky, but in about three hours it thoroughly cleared. The float in tank *C* controlled the make-up water which varied from 3000 to 4000 gallons per day. After getting our system in operation, we could run a boiler sixty days, at the end of which time we would find only ⅛ inch of scale.

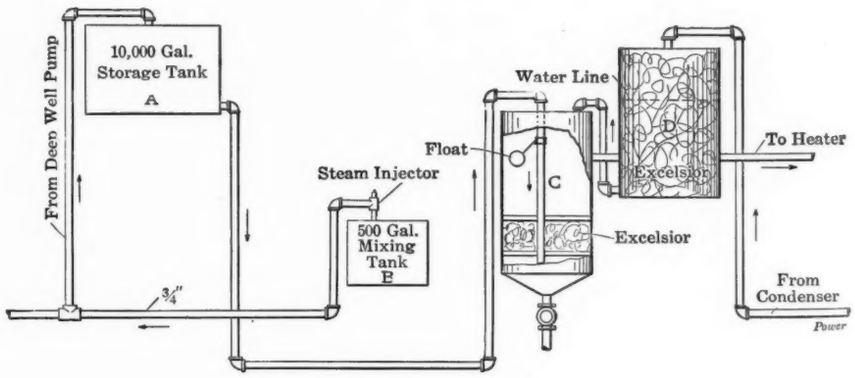
A. L. MCCULLOCH.

Santa Maria, Cal.

A Novel Pump Governor

A great many devices are employed to prevent engines from racing, but few, I believe, have seen a governor designed to prevent a pump from racing. The contrivance shown in Figs. 1 and 2 was used on a tandem-compound duplex pump, supplying water directly into the mains of a small town. The circumstances which made its use necessary are as follows: When the pump was installed the boilers carried 70 pounds of steam and at this pressure the pump ran nicely at a constant speed, thus insuring the minimum noise in the consumers' houses. Two years ago, however, the town voted to erect an electric-lighting plant, adjacent to the pumping station, the boilers of which were to carry 150 pounds of steam. In consequence, it became necessary to place a 5-inch reducing valve on the steam line to the pump. This valve gave considerable trouble by sticking and by the frequent puncturing of its metal diaphragm and allowing boiler pressure on the pump, the usual result of which was the bursting of several water pipes, the flooding of numerous cellars and innumerable complaints. Owing to the noise of the generator belts the racing pump could not be heard in the engine room.

The engineer decided to install a de-



HOMEMADE WATER-SOFTENING APPARATUS

vice that would partially shut off the steam to the pump in these cases. Fig. 2 shows the inertia governor adopted. The weight *W* is kept to its seat by spring

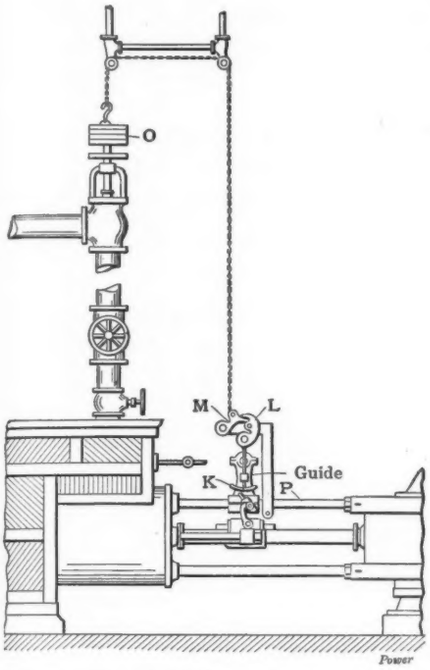


FIG. 1. GOVERNOR CONNECTED TO PUMP

A the tension of which is adjustable by collar *B*. The hook *C*, which protrudes through a slot cut in the shell of the 2-inch pipe, keeps the rod *E* from being pulled over against the stop *F* by the tension of spring *G*. The two arms of the rod *E* are forced to slide in the guides *H*. The device is secured to the crosshead of the pump as shown in Fig. 1. While the pump is working evenly and smoothly the tension of spring *A* is sufficient to overcome the inertia of weight *W;* but when the pump races, the quick returns made, will cause the weight to slide in the babbitted bearings, thus releasing pin *D*, which is pulled over toward

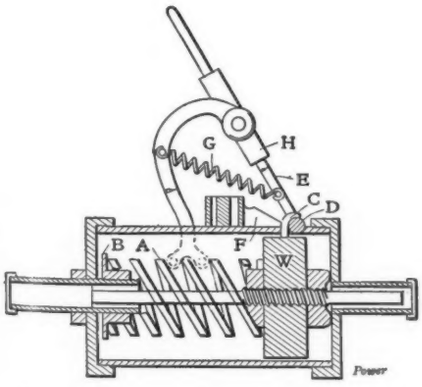


FIG. 2. SECTION THROUGH GOVERNOR

F. The rod *E* then stands nearly perpendicularly, in which position it is long enough to reach the trip plate *K*, which, as is seen in Fig. 1, is secured to the hook *L*, that holds the latch *M* from being pulled upward by the weight *O*. The yoke thread of this angle valve has been removed and the stem bushed to fit. The wheel has been pinned at such a hight that it will not allow the valve to close tightly, but will so throttle the steam as to allow the pump to continue running. A leather bumper is placed under the wheel to relieve the shock of the falling weight.

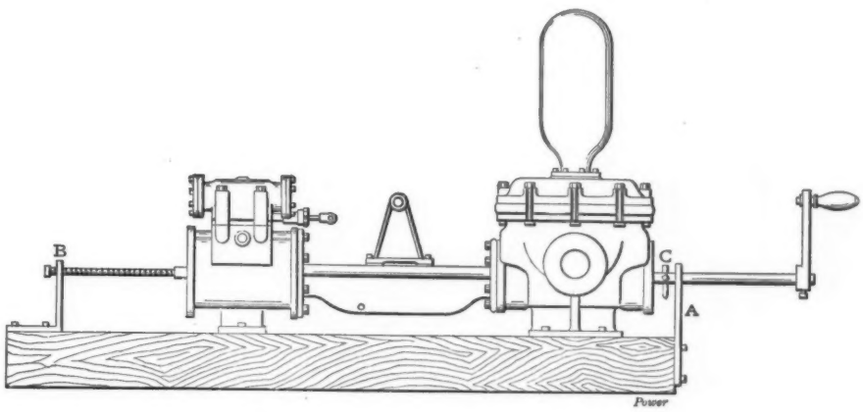
L. M. LESLIE.

Cambridge, Mass.

Boring a Pump by Hand

The operating engineer is often called upon to exercise his ingenuity in making repairs, as machine tools are not always near at hand. The illustration represents a method employed by the writer in reboring the water end of a small pump, only such tools and appliances being used in the process as are available in almost any power plant or factory. In this case the material to be bored was brass and the bore was about 3x8 inches.

The pistons, rod and packing glands were removed and a piece of cold-rolled shafting the required size was drilled to receive the tool *C*, the holes in the front ends of the pump chamber and steam cylinder acting as guides. The nearest size of shafting was found to be a trifle too small and thimbles of sheet metal were used in the holes to bush them to a snug fit.



MANNER OF BORING PUMP BY HAND

The pump was bolted firmly to a piece of timber and the iron strap *A*, having a hole in its upper end the exact size of the boring bar, was put in place, the holes marked and bored and the strap rigidly bolted to the squared end of the timber. The boring bar was then centered by means of calipers. The angle iron *B* was bolted in the same manner to the other end and the feed bolt inserted.

With one man at the crank and another operating the feed screw, a good job was accomplished, the finishing cut being taken with a broad-nosed tool.

In the same manner the writer once helped to bore the guide of an 8x10 slide-valve engine, the material in that instance having been cast iron and the base 8x19 inches. In place of the strap *A* the steady rest of a lathe was used.

F. C. HOLLY.

Yazoo City, Miss.

A Makeshift Oiling Device

The following incident occurred while I was night engineer in a lighting plant which was running under conditions of extreme overload. Additional machinery was being installed and we were trying to keep up the service till the new engines were ready to run.

One night, when going on duty, I was informed by the chief that the city counsel was to meet that night to discuss some important business in regard to granting the company a new franchise, and for me to be sure that nothing went wrong with the lights.

At about 8:30, while I was engaged in blowing out one of the small machines with an air hose, I heard a peculiar noise in the direction of the engine carrying the lighting load, and upon investigation found that the oiling device on the crank pin had broken off.

Something had to be done at once to keep the lights from going out. In desperation, I seized the air hose and a can of oil and pouring some of the oil over the end of the nozzle of the hose, blew it into the end of the crank pin as it came around. The scheme worked so well that I kept the engine running in this manner until nearly 12 o'clock, by which time the load had decreased enough to change over to another generator. The engine was then shut down and the broken oil pipe repaired, without interrupting the service in the least.

HORACE MCGIBONEY.

McAlester, Okla.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.

Perpetual Motion

In the issue of May 3, Mr. Kirlin proposes a scheme for perpetual motion and wishes to know just where the fallacy lies. His scheme, in slightly simpler form is this:

On the periphery of a submerged wheel (Fig. 1) are attached a series of watertight cylinders having weighted plungers. At *A* the plunger has dropped out into the position shown and thus displaces more water than in the position *B* where the plunger is inside the cylinder. Thus there is a force, due to the unbalanced buoyancy of the plunger at *A*, which tends to turn the wheel in the direction of the arrow. A tube *T* equalizes the air pressures inside the cylinders. Mr. Kirlin has succeeded in making his problem so complex that a mathematical proof of the fallacy is long and involved, so I will content myself with indicating it.

In the first place, where is the force which at some point in the cycle must oppose and annul the buoyant force which we have considered? It will be noticed that in the diagram the weight of the plunger in position *M* exerts a counterclockwise turning moment on the wheel which is unbalanced by the plunger at *N*. This force is weakened, but one can readily see not completely annulled, by the buoyant effect of the water. Thus we have found a force which we may assume, or prove if we like, will at some

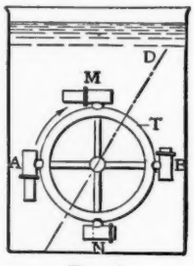


FIG. 1

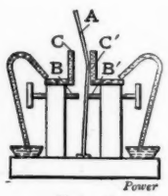


FIG. 2

point in the cycle neutralize the force due to the unbalanced buoyancy at *A*.

Now considering from another point of view, what is the theoretical efficiency of the motor? On two places in the cycle (e.g., on passing the line *D*) the plunger falls through a certain distance (call it *X*) without doing available work. Thus twice in each cycle we have to put into the machine an amount of work (considering one cylinder alone) equal to the weight of a plunger (*W*) times the distance *X*, or *2XW*. In exchange one plunger gives us in one cycle an amount of work equal to its buoyancy (*F*) times the distance (H) through which *F* acts. Now I proved by mathematics that *2X W* equals *F H*, but as it took me five hours and innumerable sheets of paper I will omit the proof here. Now when *2XW* equals *F H*, the amount of work put into the motor and the amount derived will be the same and thus the theoretical efficiency of the motor will equal 0.

I think that I have sufficiently indicated the fallacy so that any reader who is not convinced may work it out to his own satisfaction, but I promise some startling complications to the one who starts to prove that *2X W* equals *F H*.

In addition I wish to propose a problem of my own. I also have a queer motor, but instead of being a perpetual motion, it is rather a "continuous" motion which much resembles it; and the problem is not to discover why it will not work, but rather why it does work. In other words, where does the energy come from which drives my engine?

In the motor, Fig. 2, *A* is a strip of sheet gelatin, the kind we used to watch curl up in our hands when we were children. It is balanced on end and is kept from tipping over by stops *B B′* on either side. *C C′* are two pieces of blotting paper, the ends of which dip into small dishes of water.

The action is as follows:

Suppose the gelatin strip to be leaning against *B′*. The side of the strip nearest to *C′* is expanded by the action of the water vapor from *C′*. The top of the strip inclines to the left, destroying equilibrium, and the strip tips over against *B*. The side toward *C* now expands while the other side dries, and the action is repeated. This motion continues at a rate of eight or ten times a minute as long as the blotters are damp.

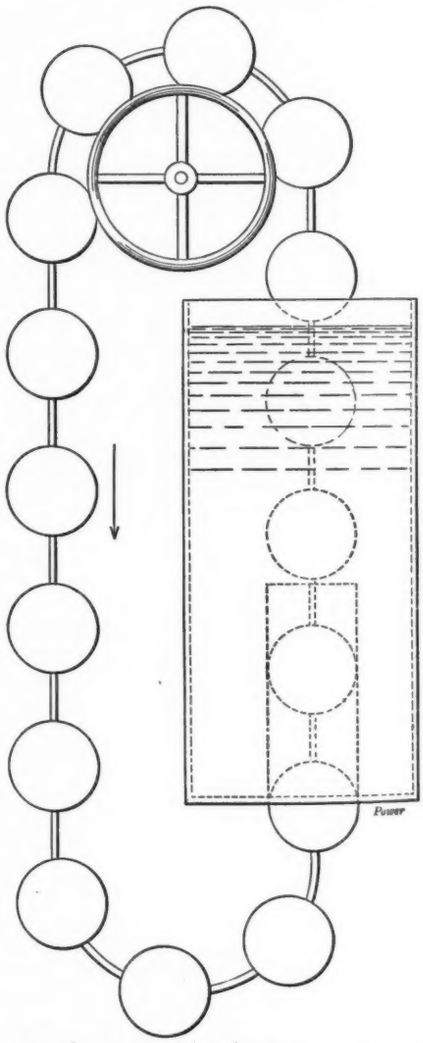
No great power possibilities, to be sure, lie in just this type of motor. One which I have on my desk, and which uses a strip of gelatin 2 inches long by ⅛ inch wide, develops as nearly as can be computed $(10)^{-11}$ horsepower. At this rate it would take about 5,000.000,000,000 of such motors to run a good-sized automobile. There is an idea, however, bound up in the contrivance, the idea of the utilization as a source of energy of heat at small "potential," i.e., at low temperature difference, which may at some time be of great interest to humanity.

V. BUSH.

Boston, Mass.

This arrangement is similar to one I had in mind long ago, except that mine had floats instead of cylinders and plungers and only part of them were in the water at a time. The sketch illustrates my idea.

The floats on the right are pulled up by their buoyancy and the ones on the left brought down by their weight, and



PERPETUAL MOTION MACHINE MADE WITH FLOATS

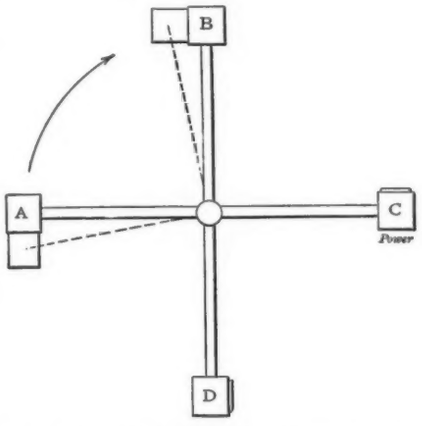
return to the water in the vessel through the opening in the bottom, which the floats were to fit tightly to prevent leakage. This was where friction came in and is the reason why my invention would not work.

F. M. PERRAS.

Taunton, Mass.

I have drawn a modified form of Mr. Kirlin's machine which employs the same principles. If it were a real perpetual-motion machine, it would run much better than his form, for in it friction is reduced to a minimum, while in his the power required to bend and unbend the carrier for the cylinders would alone cause the machine to fail.

The figure shows four arms, each carrying cylinders similar to the ones on Mr. Kirlin's device. Due to the hydrostatic pressure, it is quite evident that there will be an upward pressure on *A* tending



SIMPLIFIED FORM OF PERPETUAL MOTION MACHINE

to rotate the machine in the direction of the arrow. If we examine the figure closely, we will notice that while the centers of *C* and *D* are in line with their arms, those of *A* and *B*, due to the plungers being outside the cylinders, are not in line with the arms, but on a line drawn through the centers of the plungers, as shown. This brings a moment on each arm tending to turn the arms in a direction opposite to the arrow, and the whole mechanism will come into equilibrium when the moment due to the two plungers not being in line with the arms is balanced by the buoyant effect of the water.

In all perpetual-motion machines it is possible to show that the moments around any axis are equal to zero.

JOHN FRENCH.

Washington, D. C.

Oil Grooves in Bearings

In reply to W. C. Light's inquiry in the May 3 number, I will state that I am running two 16x24-inch engines which are without oil grooves in the bearings. They run smoothly and never heat. The speed is 165 revolutions per minute and both engines are overloaded. The engines have been running for the last 18 months without any of the bearings being rebabbitted.

P. J. POWELL.

Trout, La.

Position of Throttle

I have noticed some discussion of the above subject, and believe it is one of more than passing importance.

I have never had a serious accident happen in any power plant where I have had charge, and do not, therefore, know from experience just how it feels to stand facing the flywheel of a runaway engine while trying to close the throttle valve, but I have often thought of such a contingency and have imagined that it would be just as I once heard an engineer who had had this experience describe it to be. He said that "there seemed to be a mile of threads on the valve stem."

With the location of the throttle valve as shown in Fig. 1, the engineer must stand in line with the flywheel and the valve gear, in the case of a Corliss or similarly controlled engine, and in addition, in the case of an engine having a shaft governor, in line with any parts of the governor that might go skylarking, or he can stand behind the cylinder, which would be even more dangerous under some circumstances. In one instance he would be risking a ride on some fragment of a flywheel or other piece of wreckage, and in the other he would be taking chances of being pasted against the walls by a cylinder head, neither of which is a very joyous prospect for a life-loving mortal.

It seems to me that the usual location of the throttle wheel, as shown in Fig. 1, is without good reason. The operator is not only in line with the parts of the engine itself that would be most likely to go to pieces under unusual conditions, but is also in line with the belt, and

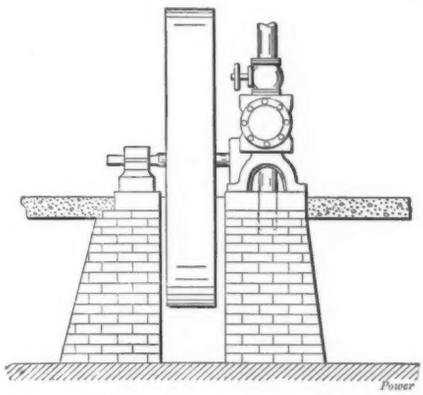


FIG. 1. USUAL LOCATION OF THROTTLE WHEEL

instances are not rare where a belt breaking has resulted in serious injury to persons who happened to be in line with one of the loose ends.

Where manipulation of the valve gear in starting or stopping is not required, I can see no reason why the location of the throttle wheel should not be as shown in Fig. 2. This is not convenient with Corliss or similar valve gears for the reason that it is considered necessary that the throttle valve and the starting bar both be within reach of the engineer at the same time. This is not absolutely necessary but is very convenient. With the wheel located as shown in Fig. 2, the engineer can stand where he will be out of the path of flying parts in case of a flywheel explosion or an accident to the valve gear or governor. He is also able to stand where he is not menaced by the cylinder head.

In Fig. 3 the wheel is located so that it is possible to reach the starting bar and the wheel at the same time. It is

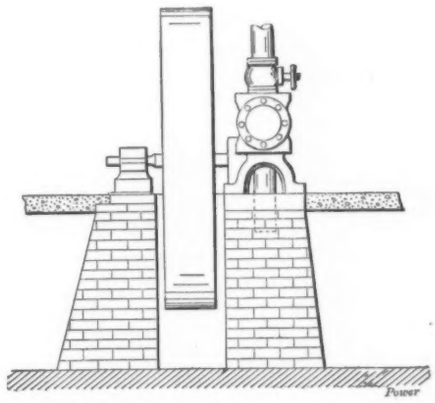


FIG. 2. INCONVENIENT LOCATION OF THROTTLE WHEEL

clear that the engineer can, in case of danger, stand on the clear side of the engine while closing the valve.

It may be considered a matter of little importance, as to where the wheel is located, since the cases of loss of life or limb are so few. At the same time, I have noticed that engineers show a desire to stand as far from the lines of danger as possible; in fact, I have felt the same desire myself. Since, no matter how careful we are, things may go wrong and damage result, it must appear that the question of the safest arrangement of the means for the control of the engine is one of considerable importance. We should be disposed to tolerate some slight inconvenience in order to secure the greatest possible safety.

I know of an instance of an engineer losing his life in an engine wreck at Keokuk, Ia., because, in trying to close the throttle valve, he was compelled to stand in line with the working parts while the engine was running away. If the throttle wheel had been located as in Fig. 2 or 3, he would have been able to have stood out of the line of the flying parts of the governor and flywheel which were wrecked and would not have lost his life.

When the way is comparatively clear and safe, a man will generally be more prompt to act than when he knows he is going into certain danger. This is not always the case, but with many men it is a matter of habit to count the cost of every act.

I had an experience which is to the point. I was in charge of a small lighting plant in which there were three generating sets, each of which included two direct-current machines running in series on a three-wire system, and one alternating-current generator. I was leaving the plant one night, and had gone about half a block when I noticed a change in the noise of the machinery. A heavy ground had occurred on one side of the direct-current system. This caused the machine operating on that side to throw its belt. It so happened that the power-plant lights were on the other side so that when I ran back to the engine room I could see the situation clearly. The engine was still running and the belt was thrashing about like a mad snake in a battle; the assistant was trying to make up his mind whether to stand and watch it or to leave the premises. Luckily the belt kept clear of the other one which ran on another wheel by its side. I got to the throttle valve and closed it. I would have given a pretty penny to have had that throttle-valve handwheel facing as shown in Fig. 2 or 3, so that I could have stood out of line with the belt that night.

Another case came under my observation which should emphasize the importance of observing good judgment in the location of valves, as well as of engines. The engine, in this case, was placed so that its center line coincided with that of the door leading from the engine room to the boiler room. One day the engine, which was equipped with an old Westinghouse governor, ran away on account of a link becoming disconnected. The engineer was in the boiler room, and as

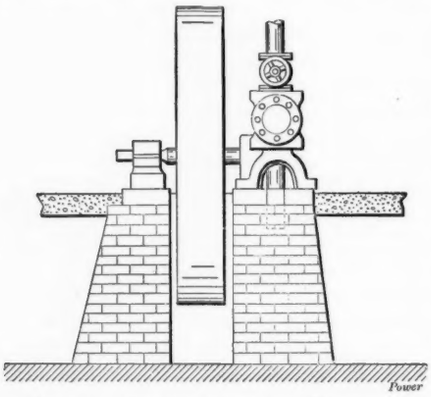


FIG. 3. ARRANGEMENT OF THROTTLE WHEEL WHICH IS CONVENIENT UNDER MOST CONDITIONS

soon as he noticed indications of trouble he headed for the engine room. When he arrived at the door, the engine was behaving in a manner which was so startling that he came to the conclusion that there were safer routes to the engine throttle than via the aforementioned door. He ran to the rear door of the boiler room, partly around the boiler and engine rooms on the outside, and climbed into the engine room through a window. In the meantime the fireman had run the gauntlet by way of the door, and shut down the engine before the engineer arrived by way of the route of safety. In this case the throttle valve was located as shown in Fig. 2, which I consider the best arrangement for engines that require no hand manipulation of the valve gear in starting.

In all cases when installing power-plant equipment, every possible contingency should be given consideration. Not only the things that are certainties of everyday occurrence should have attention, but the things that are remotely possible should be considered as well. There is not, in my opinion, any good reason why the engineer should be required to go into greater danger than is necessary, when meeting contingencies that experience teaches us may arise at any time. Even if the failure to follow the course of greatest safety occasioned no more than the loss of one life in a hundred years out of the total of the earth's population, it would be worth our serious consideration.

WILLIAM WESTERFIELD.

Lincoln, Neb.

Buying Coal on a Horse-power Basis

Referring to the article, "Buying Coal on a B.t.u. Basis from a Seller's Point of View," in the January number of the *Journal* of the Worcester Polytechnic Institute, by Wallace C. Rogers, extracts from which were published in POWER for April 12, I would like to comment on Mr. Rogers' statements and present a few additional facts which ought to be considered in this connection.

His main contention is that a chemical analysis and a determination of the heat value in coals are of little value in practice, and that "the measure of efficiency should be cost per kilowatt-hour for the electrical engineer, per horsepower for the mechanical engineer and per unit of product for the manufacturer." I quite agree that the value of anything is what you can get out of it for a particular purpose, chargeable to profit and loss.

Analyses and fire-room tests should go together to get all and the best data on coal. Analyses will disclose what the coal is and what its best value is as a basis for burning. It has nothing to do with boiler setting or coal burning. The best coal may be burned under a poor setting and be badly fired while a comparatively poor coal burned under better conditions may give higher results in evaporation and power produced.

A consumer, of course, may say, as he often does, "It is the results I am looking for." The proposition, the better the coal the better the results, needs no demonstration. It is self-evident, and the best coal will give the best results.

Analyses and heat units give the consumer a knowledge of the value of the coal he is buying. They protect him in his purchases and form a basis for the work in firing. If he buys a good grade of coal and gets poor results in burning, he knows there is something faulty at his end which needs attention.

Right here I would like to ask, if coal is to be bought and sold on any basis, how many coal dealers would prefer to sell on a basis of the average fire-room practice in preference to analyses made by disinterested chemists? The fact of the matter is, that in too many cases coal dealers prefer to take chances with the too often crude conditions existing in a boiler house, than, to sell on a basis of actual value.

The buying and selling of coal is not different from the dealing in other commodities, and when both parties have established a fair basis of trade, transactions on this basis will result to the mutual advantage of both. To enter into an agreement on any other basis or with any other intent can be only with a purpose to acquire some unfair advantage.

I will mention briefly some of Mr. Rogers' viewpoints. First, he represents, as a selling agent, miners and shippers of bituminous coal and it is apparent from the position he takes that he would prefer to sell coal on a no-test basis. He refers to specifications for coal presented by purchasing agents to the "coal man, containing a formidable list of penalties several pages long." In this connection I would say that it is perfectly right for a buyer to specify what he wants and under what conditions he will agree to purchase. A seller may decline these terms with perfect propriety. Why should not coal be bought and sold on the unit basis of value, as well as gold, silver or iron ore, or a thousand other natural commodities?

In the preparation of specifications for coal, there should be stated first, a standard of quality desired, and a base price for this. There should be certain maximum limits of departure from this which are permissible. If no other elements enter, the coal could be paid for in proportion to its heat units when used for steam making. But other elements do enter, as cost to handle, removal of ashes, freight, etc., and deductions for these items in the case of inferior quality are not penalties, and it would be better if this word was not used, but an equivalent for deficient value.

I believe specifications for coal should be liberal and reasonable, representing actual values as nearly as possible and in no sense containing penalties, which are of the nature of punishments. It should always be possible for a buyer to reject any coal which indicates a disposition on the part of the dealer to take any advantage of him, or is of such a quality as to impair his product. Speci-

fications for coal or anything else are of as much advantage to the seller as to the buyer, and are intended only as a fair basis of trade.

Mr. Rogers' comments on the sampling of coal disclose a lack of even the rudiments of sampling and are intended to discredit coal testing. We would be pleased to have his views on the sampling of cargoes of various ores, fertilizers, feeding stuffs, pig iron, bullion, etc., which if my memory serves me rightly has been done to the reasonable satisfaction of trade and commerce for a good many years past. It goes without saying that proper adequate sampling is indispensable. Many of Mr. Rogers' comments can only be intended to amuse; some unwittingly advocate what he attempts to discredit.

If "a purchaser pays a higher price and gets an inferior coal when buying on a B.t.u. basis," certainly the "coal man" is not penalized and the specifications cannot have been burdensome. If "Smith guaranteed the very best grade of coal with high B.t.u., etc., and got the order, and shipped the very poorest and cheapest coal he could buy; took all the penalties, and made money," he was dishonest, took advantage of his customer, was a scoundrel and unfit to do business anywhere.

To be sure, a cheap, low-grade coal can be best sold on its heat value. The testing of coal is not to guarantee any particular grade of coal but to certify intrinsic values. Boiler tests are very important to determine boiler-room practice and are of great assistance to this end, but can never take the place of the fundamental valuing of coal by analyses and determinations of heat units.

MARTIN L. GRIFFIN.

Springfield, Mass.

Boiler Room Ventilation

The above has lately been the subject of much discussion in the columns of POWER and coincidentally the question has been forced upon my notice in reference to the plant I am at present operating. Our manager tells me that I am wasting fuel by keeping the boiler-room door open, and that the correct way is to keep all doors closed. I admit there is some truth in his assertion, from the fact that all the steam pipes are uncovered. He contends that covering steam pipes is quite unnecessary if the boiler room is kept tightly closed. But as the temperature of my steam is 373 degrees, I believe that unless the air in the boiler room reaches this temperature there will undoubtedly be a loss of heat as long as the pipes are uncovered. Further, I point out that a temperature sufficient to prevent loss of heat in pipes is out of the range of human endurance; still he returns to the charge in a few days if he sees the door open.

The boiler shell is covered with brick and the top of the boiler-room door is 10 feet below the lines of steam piping; therefore, the heated air above does not escape, but only that which comes from the furnace front and smoke-box doors. I have adopted his suggestion, and closed up tight with the result that the boiler room is an inferno. I used to potter about cleaning up fittings, etc., but now I leave them severely alone until a more convenient season. I should like the opinion of other engineers upon this subject.

J. L. SHELL.

Prince Albert, Canada.

Capacity of Deep-well Pumps

Mr. Dew asks about the capacity of a deep-well pump, neglecting the slip. It is unnecessary to go farther than his diagram, which is shown on page 813 of the May 3 issue of POWER.

Referring to this diagram, it is evident that the upper bucket passing downward will displace the same amount of water in the cylinder that the lower bucket will in making its upward stroke. This fact is obvious since the lower side of the upper bucket has the same area as the upper side of the lower bucket, and they both make the same stroke. This being the case, the displacement per revolution will be twice the amount displaced by the lower bucket.

J. M. ROW.

Fort Monroe, Va.

Putting It up to the "Old Man"

The question of putting it up to the "Old Man" has interested me a good deal. When one stops to consider that there are many kinds of "Old Man," the advice given in a recent editorial may not always pan out.

The "Old Man" may be ready to use a suggestion if it is made clear that there will be a saving, but the chances are that he will prefer to be on the safe side and keep his money in the bank, rather than run a chance of losing out in the end because the engineer did not calculate correctly.

It has been stated many times that the managers of steam plants do not depend upon their engineers, taking the ground that outside information is more valuable. In one instance this was brought out in a rather humorous manner. In a certain boiler plant it was desired to add another boiler, and, in order to do so, it would be necessary to demolish a portion of the factory which adjoined the boiler room. The new boiler would have to be set where a portion of the factory stood. In order that the wall of the original boiler room could be removed and leave the boilers all in the same room, the engineer suggested that a pier be erected close to the setting of the new boiler and the roof supported in the center by it.

The management, however, decided that expert advice was necessary and the services of a mechanical engineer were secured. This worthy came and had elaborate plans drawn of the boiler room with a beautiful arch forming a dividing line between the old and new boiler rooms. This arch effect, while not making the boiler room hideous, was so placed that the fireman when firing would have been apt to hit the back of his hand, beside being in the way of his performing other work. When the engineer pointed out the defects, the "Old Man" took a tumble and decided that perhaps the engineer did know something and let him go ahead and have the boiler room fixed up as he wanted it. The "Old Man" had a nice little bill from the mechanical engineer, but I never heard of his offering the engineer a raise in pay. In fact, it is not very often that the engineer gets his just dues in this regard. He may effect a large saving and in return get only a meager raise.

L. M. HOLDER.

Ouimet, Canada.

Double Expansion Engine

The article by J. C. Morris, entitled, "Headless Twin Cylinder Engine," in the May 10 issue of POWER, is of special interest to me, for an engine known as the Malugen engine, similar in some respects to Dowling's, has been very much exploited in the *Nashville Press* for the last two years or more.

The chief distinguishing feature lies in the construction being different in that the one he describes has two cylinders and two pistons working within each, whereas Malugen used only one cylinder instead, with three pistons working within it. Both entertained the same delusion that a given amount of steam, acting against and between two heads moving in opposite directions, would accomplish double the amount of work done by a common double-acting single-piston engine.

No account seems to have been taken of the fact that the displacement between the two heads, to be filled with steam, is twice the length of stroke, or just as great again as it would be in a simple engine.

Practically the same thing is shown and described in Stevens' "Mechanical Catechism," published in 1899, and it would not surprise me if the idea was not original with Mr. Malugen.

LOYD V. BEETS.

Nashville, Tenn.

A. S. M. E. Convention, Atlantic City

After twenty-five years the mechanical engineers returned this season to Atlantic City for their spring meeting. While the attendance was not large and the attractions of the Broad Board Walk encroached somewhat upon the number of celebrants at the Black Board Talk, a varied and attractive program had been provided and a sufficient number appeared who were interested in each of the subjects treated to discuss it to the limit of the available time. In fact it appears to be the history of the recent meetings of the society that a dearth of time rather than of ideas and of the disposition to express them has prevailed.

The sessions were held in the solarium of the Marlborough-Blenheim, the president, George Westinghouse, and vice-president, Charles W. Baker, presided over the sessions and Chairman J. A. Bibbins of the Gas Power Section over the session especially devoted to that subject.

At the opening session a resolution relating to pending legislation requiring the licensing of professional engineers was introduced by Col. E. D. Meier, but evoked no discussion beyond the expression by Mr. Baker that the older members of the profession were inclined to regard askance any movement in that direction.

The Wednesday forenoon session was devoted to machine tools. That of Thursday forenoon at which the gas-power papers were presented, was the most interesting from the power standpoint.

GAS POWER SECTION

At this session four unusually interesting papers were presented. The first one was by Prof. Arthur J. Frith, and was entitled

A Regenerator Cycle for Gas Engines

The proposed cycle is radically different from those previously followed in gas-engine operation, in that it is proposed to use subadiabatic expansion; that is, withdraw heat from the expanding gases so that the release pressure and temperature are brought down to equality with the admission pressure and temperature. The heat thus withdrawn is supposed to be stored in a regenerator to be given up again during the compression stroke. Professor Frith proposes to use two cylinders and cranks, with the crank pins some 90 degrees apart; one crank has a much shorter throw than the other, and the cylinder corresponding to this crank handles gas alone during the compression stroke while the other cylinder compresses air alone. The crank of the gas-compressing piston is ahead of the other one. The cylinders are side by side and connected by the regenerator. While the gas is being compressed it receives heat from the regenerator until temperatures are equalized; meanwhile air compression is going on in the other cylinder, but 90 degrees behind the gas-compression cycle. When the resultant pressure of the two compressing processes is maximum, a valve is opened which allows the gas and air to mix, and the mixture is fired. Expansion begins in the smaller cylinder and is continued in the larger cylinder, the regenerator taking out heat from the burning gases.

In the discussion of the paper, Sanford A. Moss pointed out that the proposed cycle was open to the objection that the regenerator was expected to absorb heat from the burning gases throughout expansion to atmospheric temperature, although its own temperature could never go even as low as the temperature of compression.

Gas Engines for Driving Alternators

The second paper, by H. G. Reist, described briefly the conditions of parallel operation with alternating-current generators and explained that desirable characteristics in gas engines for this kind of service are high speed, light flywheels, many cylinders, and power impulses distributed as far as practicable over each revolution of the shaft. High speed permits the use of fewer field-magnet poles on the generator, which increases the allowable variation in angular velocity; a light flywheel makes it easier for the generator to correct any tendency to get out of step; multiplicity of cylinders and distribution of power impulses give more even turning moment and less tendency toward wide variations in angular velocity.

Two Proposed Units of Power

Prof. W. T. Magruder, in a paper of this title, pointed out the absurdity of rating boilers and gas producers in "horsepower," no mechanical work being done by these pieces of apparatus, and proposed rating boilers in "boiler powers" and producers in "gas powers." The suggested unit "boiler power" was defined as being equal to 33,000 B.t.u. per hour delivered by a boiler, a steam main or hot-water main, or added to the feed water of a boiler. One "gas power," the author suggested, should be equal to 10,000 B.t.u. delivered or used per hour in either gaseous or liquid fuel.

Discussing the paper, H. G. Stott made the excellent suggestion that instead of using the purely empirical unit of 33,000 B.t.u. per hour and calling it a "boiler power," the unit be made 34,120 B.t.u. per hour and called the "thurston." The reason for selecting this figure was that it would be a multiple of the heat equivalent (3412 B.t.u. per hour) of one kilowatt, which is a rational unit.

Operating Experiences with a Blast Furnace Gas Power Plant

Heinrich J. Freyn, of the engineering staff of the South Chicago plant of the Illinois Steel Company, presented one of the most valuable and comprehensive papers ever recorded in the proceedings of an engineering society. The treatment of the subject is so detailed and thorough that it is impossible to abstract the paper adequately.

The plant discussed in the paper consists of four 2000-kilowatt gas-engine generators receiving blast-furnace gas cleaned in a preliminary and secondary washing plant. The former consists of two tangential dry-dust catchers and two wet scrubbers, or hurdle washers, and the latter are Theisen gas washers. The gas is supplied by six blast furnaces, and had in 1909 an average heat value of 98.3 B.t.u. per cubic foot, and contained 26.51 per cent CO, 3.57 per cent. H, and 0.196 per cent. CH_4. The temperature of the gas entering the gas-cleaning plant averages 332.5 degrees Fahrenheit, which is reduced during the cleaning process practically to atmospheric temperature at the engines. The average raw-gas pressure was 9.29 inches of water, while gas of 4-inch pressure is delivered by a 1000,000-cubic foot gas holder. The average amount of flue dust in the dry-cleaned gas was 1.53 grains per cubic foot, which during the washing process was reduced to 0.0058 grain per cubic foot. The wet scrubbers took out 80 per cent., and the secondary cleaning plant 98 per cent. of the amount of dust received, respectively. The total efficiency of the gas-washing plant was 99.5 per cent. The amount of moisture in the engine gas averaged 5.62 grains, against 3.49 grains in the atmospheric air. The amount of water used for gas cleaning averaged 102 gallons per 1000 cubic feet of gas cleaned, 83 gallons of which were used in the wet scrubbers and 19 gallons in the Theisen washers. The power consumed in the gas-cleaning plant was 3.3 per cent. of the gas-engine output. The load factor for the year was 72 per cent. and the average running time was 77 per cent. of the total possible time. The thermal brake efficiency of the plant, as determined continuously by venturi meter, averaged 20.8 per cent. for 1909. The total output of the station was 50,494,100 kilowatt-hours. The heat consumption of the engines, at 70 per cent. of their full capacity, averaged 12,000 B.t.u. per hour per brake-horsepower.

In the discussion of Mr. Freyn's paper, Joseph Morgan, of the Cambria Works,

described his experiences with dry dust catchers for blast-furnace gas. The downcomers to the first catchers entered in the center of the drums, and the gas was not well cleaned. Upon changing the entrance from central to tangential, the catchers abstracted four times as much dust as they had been taking out with the central entrance; this was due to the centrifugal effect upon the dust particles.

An engineer of the Pennsylvania Steel Company expressed the opinion that one dry cleaner is sufficient, for the reason that the second one does only 15 per cent. of the dry cleaning and is therefore unnecessarily expensive. He also said that he had found a simple tower better for wet cleaning than a tower filled with grids or other obstructions for breaking up the flow of gas and presenting multitudinous wet surfaces. His company uses a simple tower with a revolving water distributer at the top, which delivers a well distributed and finely divided shower down the tower to a pool at the bottom. The incoming gas pipe turns downward and delivers the hot gas on the surface of the pool, evaporating some of the water; the steam rises and is condensed by the downcoming shower into a fine mist, which picks out the dust particles with maximum efficacy. The gas leaves the tower by a side outlet just beneath the water distributer at the top of the tower. This construction, he said, has the advantage of compactness without opposing the flow of the gas through it.

Thursday Afternoon and Evening

The Thursday afternoon session was devoted to miscellaneous subjects, none relating to power, although H. L. Gantt pointed out in presenting his paper upon "The Mechanical Engineer and the Textile Industry" that the mechanical engineer had been in the past too much of a power-plant engineer, had confined his activities too much to the metal-working industries, and bespoke for him a wider field and broader scope.

On Thursday evening, honorary membership was conferred upon Rear-admiral George W. Melville, United States Navy, Retired. The presentation was made by President Westinghouse in one of the parlors of the Blenheim, and with the reception and dance which followed was the only formal evening function of the social program. The admiral accepted the honor with a few well chosen words, followed by an address of felicitation by Sir William H. White, K. C. B., who was president of the Institution of Mechanical Engineers of Great Britain at the time of the visit of the American Society in 1900, and who had previously received the same honor himself. The following address, written by Admiral Melville, was then read by Mr. Walter M. McFarland.

The Engineer's Duty as a Citizen

Doubtless everyone present has read Macaulay's famous chapter in his "History of England," which describes the conditions obtaining in 1685. This chapter is one of the most wonderful descriptions in all literature, giving, as it does, the details of every feature of the life of that time, some two hundred years ago. I refer to this account because I want you to contrast it with the conditions of today, which are so familiar to you that it requires some effort to remember that the conveniences and comfort of the poor man of today are beyond the wildest dreams of the wealthiest men of the period described by Macaulay. I may remind you that this was a time when there were no sidewalks, and the streets were unlighted; when the highways became bogs in rainy weather, and highway robbery was almost a recognized profession; when sanitation and sewerage were unknown and refuse heaps accumulated under the windows of the great and the wealthy; when it was dangerous to go out alone at night, and when it was still legal to hang the unfortunate who stole a loaf of bread.

Macaulay remarks in one place that the nobility, at such fashionable watering places as Bath, had to put up with accommodations at which their servants would, when he wrote (1850), turn up their noses.

Now, when we make the comparison between the two periods, and when we remember that there is hardly a branch of human activity in which there has not been the greatest improvement, we are naturally led to ask to whom is that improvement due.

In all fairness, we should doubtless have to say that many or most of the professions have had a part in the amelioration of conditions, although the student of history remembers with regret how the great lawyers opposed the remission of the death penalty for what we would now consider minor offenses. The doctors undoubtedly are entitled to much credit for improvement in medicine, surgery, sanitation and hygiene, and we might go on to give credit to others.

It seems to me, however, that when some future Macaulay describes the condition of the United States at the beginning of the twentieth century, and attempts to award the credit for the existing comforts and conveniences, the major part must be given to the profession of engineering. Within one hundred years after the time described by Macaulay, Watt had so far perfected the steam engine as to bring about the beginnings of the factory system which has made possible cheap clothing and cheap articles of manufacture of every kind.

In a century and a half, the steamboat and the railroad have come into being.

Then, we have gas for illumination and the telegraph for rapid communication, and so on down the line to the present day with the electric light, the electric railroad and the telephone. Every one of these improvements is due to the engineer.

Added to the superior facilities of communication by railroad and steamer, we have mechanical refrigeration, which enables the densely populated countries of the old world to be supplied with meats from the great plains of the new, and these superior means of transportation have provided the rapid movement of food products so that the whole world contributes to the comforts and delicacies of our table, no matter where we may be.

The contrast between the great cities of the period described by Macaulay and those of today is startling. They were without the conveniences which a country town of moderate size would now consider absolute necessities. The system of water distribution, sewerage, street paving, etc., is all the work of the engineer, and filtration plants are obviously an engineering work, even if we consider their inception due to the medical men.

Perhaps you are asking yourselves why I should think it necessary to go into this detail about matters which are of common knowledge, and when their mention can give little additional information. My reason is this: I want to emphasize the fact as a basis to discuss the question, What does the engineer owe to society when society owes so much to the engineer?

In the early history of the race, when war was the almost constant condition, it was inevitable that the great warrior should become the leader and ruler of the people. As time went on, the engineer developed, as we know from the wonderful works of antiquity like the great aqueducts, the bridges, the tunnels and the roads; but, from the past, had come the tradition lodging leadership in the warrior caste, where it remained for many centuries, and, indeed, has still a tendency to remain in monarchial countries.

During the last century, wars have been less frequent; and, due to the work of the engineer, commerce has become so prominent that, while the hereditary nobility linger on the scene, their titles have become almost meaningless. This was particularly noticeable when one of the English dukes served in the Quartermaster's department during the Boer war in a subordinate capacity, and still more so in the war between Russia and Japan, when only one Russian general was a member of the nobility.

I think you will see the point to which I am trying to lead up; namely, that in this "age of the engineer," he should not rest content simply with doing the work which makes for our comfort and happiness, at the command of other men who are lawyers or simply business men, but

that the engineer himself should take a vital and directing part in the administration of affairs. I know the objection that at once occurs to almost every mind; namely, that an engineer's professional work is so engrossing and exacting that it is impossible for him to become a politician in the sense that a politician is a man who gives all his time to pulling wires and filling offices. This is doubtless true, but engineers, like other men, can find time to attend to business matters which affect them personally. In other words, where it is a matter of self-interest, the engineer, like other men, can find time for this extra work.

Now, we Americans are very fond of claiming that we have the greatest country, and the freest and best Government in the world. That Government, however, for its efficiency and integrity, depends upon us as citizens, and it ought to be a matter of the greatest pride to every American to feel that he is doing his part, so far as lies in him, to make the country and its Government better and happier every year.

I have reminded you of the enormously important part which the engineer plays in the life of today, and it seems to me that for this very reason it is incumbent upon him, more than upon most other men, to take a vital interest in the work of government, and to lend his trained ability and judgment to its perfection.

I do not mean, of course, that the engineer should do routine professional work for the Government without compensation, but I do mean that in the discussion of public improvements and the administration of Government departments, the engineer should take an active public stand so as to influence and guide the nonexpert part of the population in right ways of thinking.

It is notorious that, in the past, enormous amounts of money have been squandered on great public works because they were undertaken in a way which every engineer knew must be inefficient and uneconomical. Occasionally, some engineer raises his voice, but too often only to be jeered at as a crank, instead of receiving thanks. If all of us, as engineers, had a keen sense of our duty in this respect, and would properly utilize our experience and ability through the daily press, the magazines and the reviews; by public discussion, and in the daily intercourse of life, as well as by impressing the truth upon our representatives in municipal and national affairs, I believe we would accomplish an immense amount of good.

It will be understood, I am sure, that I refer almost entirely to the relations of the engineer to society in general, and not to other professional men. For many years, engineers have been most generous in making public to their technical brethren the results of their experience, and our own proceedings are full of instances. It would be impossible to name more than a few, but perhaps the most notable case was that of Past President Taylor when he published the results of his life work of research on the Art of Cutting Metals.

One of the problems of foremost importance at the present time is that of the management of labor so as to secure efficient work and satisfied men. It is probable that, as far as skilled labor is concerned, the direction of more than 90 per cent. is in the hands of engineers. Most emphatically is this case where engineers owe a great duty to society. It is, therefore, an especial pleasure to recognize that some of our own members have played a foremost part in the best work that has been done in devising plans for compensating labor that will stimulate the men to their best efforts, and reward them adequately. The names of Halsey, Taylor, Gantt and Emerson will at once occur to you.

It would be inappropriate in this brief address to attempt any discussion in detail of the labor problem, but I feel that I shall voice the sentiment of everyone present when I say that the effort of every patriotic American should be exerted to maintain absolute freedom of contract in labor matters as in all others. Just as we are opposed to monopoly by capital, so we are to the same thing by labor. No reasonable man objects to labor organizations, as such. They have undoubtedly been the cause of much benefit to the men. The danger with them, as with political organizations, is the formation of a "machine," which utilizes the organization solely for the selfish interests of the members of the machine. There can be no doubt whatever that many strikes are made against the real wishes of a majority of the men, who are overborne by the machine and its adherents; and it is also true that the net results of nearly all strikes is an actual loss to the men.

The problem is an exceedingly difficult one, and it requires the greatest wisdom, patience and tact for its complete solution; if, indeed, taking human nature as it is, we can ever hope for its removal from the list of worries of the manager of great enterprises.

Many of the questions which are prominently before the public at the present time are peculiarly such as require engineering knowledge for their proper understanding and regulation. The word "Trust" has come to have such a sinister meaning that it is only necessary to fasten that word upon an enterprise to render it criminal in the popular estimation. We have recently heard a great deal about the so called "Water Power Trust," the charge being that all the available power sites were being grabbed so as to subject our citizens at some future time to the payment of tribute for electric power derived from them. I am not concerned, at the moment, to discuss the question of monopoly, which we all deprecate, but to point out that engineers know that these water powers cannot be made available except by the expenditure of large sums of money. Indeed, it would be easy to point out the fortunes that have been lost in the attempted exploitation of these supposedly lucrative natural gifts. The public is utterly misled by statements that these power sites are obtained for nothing, their idea being that the development is a matter of small expense. Here, the engineer can do a work of real benefit by disseminating correct information.

Again, in the consideration of Public Service Corporations, the engineer knows the cost of installation and operation, and so can discuss intelligently whether rates are fair or exorbitant; whether capital represents real investment or water. These are problems of the greatest importance, and for their proper solution, the electorate needs training, which can be given by no one else so well as by the engineer.

About a year ago, at our Washington meeting, I did what I could along this line in the way of pointing out the mistakes which have been made in connection with navy-yard organization, and this illustrates very clearly what I am advocating for all engineers. Here was a great department of the Government for which the annual appropriation now exceeds one hundred millions of dollars. Its administration had fallen into the hands of a man who proved himself entirely incompetent, and who started to make changes in the entire administration which would have been ruinous to efficiency, and yet, hardly a voice was raised in opposition. I even heard of a case where one of our leading engineering journals refused to publish a criticism of this system which was submitted to them through a man whom they knew and esteemed most highly, but who stated that the author was so situated that he could not permit his name to be presented. Not only would the magazine not print the article which was submitted, but they did not take enough interest in this most important subject to study it for themselves and then comment upon it.

I would not be understood as implying that engineers never show public spirit in such ways as I have suggested; there are too many instances to the contrary. Our own society and others, which have taken part in the movement for conservation of our natural resources, have set a good example, and other cases could be cited where individual engineers have shown commendable enthusiasm.

These are, however, mostly cases of unusual importance and relatively infrequent. What I am pleading for is the habit of mind in all engineers which will cause them to take an active part in all public questions, great or small, where

their knowledge and experience will enable them to do things for the common good.

The movement which is on foot, by the Congress to have established a Bureau of Mines, suggests an opportunity for the engineer to take an active part in public affairs. It is a question in my mind whether this idea might not be developed a little further by providing for a department, with a Cabinet officer at the head, to be called the Department of Mines and Manufacture, with the scope which that title would imply.

When we think of the enormous values represented by the industries which would come within the purview of such a department, it seems only reasonable that they should be under the care of a Cabinet officer. If we are told, in reply to this, that there is already the Bureau of Corporations in the Department of Commerce and Labor, we need, perhaps, to be pardoned for saying that what would be expected of the new department would be such fostering care, under the direction of experts, as would increase the efficiency of various branches of industry, instead of an office whose function seems mainly to inspire corporations with awe, and, as some of them think, to interfere with their legitimate expansion. In any event, whether a department or a bureau is organized, engineers should see that its personnel is composed of experts who can be of some real help in the advancement of the interests of our great industries.

We have often heard in the past complaint by engineers that the profession did not receive the praise and credit which were its due for its splendid work. This is true enough, but is the reason not very largely because the engineer hitherto has been content to do the work and then fade into the background, leaving the talking and the management to the lawyer and the politician? Of course, we cannot expect young engineers, occupying subordinate positions, to take a very prominent part in public affairs, but with the advance of technical education, the condition has now come about when, more and more, the presidents and other high officials of our large corporations are engineers by training and experience. It is to these men, whose talents and trained ability have made them the leaders in manufacturing and in business, that the country has a right to look for leaders in the affairs of Government, and it seems to me that not until the engineer, of all grades, has done his part toward the promotion of the highest efficiency of the Government can he truly say that he is, in the fullest sense of the term, a good citizen of the Republic.

Friday Session

The final session on Friday forenoon was devoted to the consideration of papers upon power transmission. Henry Hess, of ball-bearing renown, presented one upon "Improvements in Line Shaft Hangers and Bearings," giving in detail the actual and relative first cost of a line-shaft installation consisting of hangers, boxes, shaft pulleys and belt transmitting 40 horsepower at 200 revolutions per minute on plain bearings and then on ball bearings at 600 revolutions. The first cost of the ball-bearing installation was 21 per cent. less than the other with an annually recurrent saving of $36.90 in power. The discussion did not question these figures but brought out interesting points in regard to wear and endurance which will be considered later. Professor Magruder presented "An Experimental Analysis of a Friction Clutch Coupling," Prof. C. M. Garland described "An Improved Absorption Dynamometer," and S. H. Weaver, of the General Electric Company, of Schenectady, presented an interesting discussion of "Critical Speed Calculation," presenting formulas whereby the speeds at which rotating unbalanced bodies will vibrate most pronouncedly may be calculated.

Entertainment

The entertainment, besides the reception already referred to, consisted of a reception and tea at the Atlantic City County Club on Wednesday afternoon, a vaudeville entertainment on the Steel Pier on Wednesday evening, teas each afternoon and informal receptions in the evening at the hotel, with unlimited admissions to the piers and use of the wheelchairs. The entertainment committee, consisting of the entire Philadelphia membership, received the usual acknowledgement of its generous hospitality.

Vertical Boiler on Drydock Explodes

By Warren O. Rogers

This boiler, which was of the submerged-tube vertical type, and had seen nineteen years of service, let go when carrying 93 pounds pressure. Four men were injured.

Four men were injured when a vertical boiler used to supply steam to a floating-drydock engine belonging to the Tietjen & Lang Company, Hoboken, N. J., exploded Thursday, May 19, at 8:45 a.m. The boiler was installed on one side of the drydock, and together with the engine was housed in a small wooden building, which was demolished. As a result of the explosion the flywheel of the engine was wrecked, and the boiler blown against one side of the dock, then falling back to its foundation. Three of the injured men were close to the boiler when it exploded, but the one most severely injured was working on the other side of the dock and protected from the flying fragments of the building and escaping steam. His injuries were due to falling from a scaffold.

The boiler was of the vertical internally fired type, 12¼ feet long, 72 inches in diameter, and contained 379 two-inch tubes. The outer shell was made of ½-inch plate as was also the firebox sheet; the latter sheet, however, was irregular, having been reduced to 7/32 inch in places. The tube heads were ½ inch thick. The longitudinal seam of the outer shell was a triple-riveted lap joint, the pitch of the rivets being 2¾ inches, and as far as could be determined the rivets were 13/16 inch in diameter.

The cone of the boiler, extending from the top tube sheet to the top head, was not braced to the sides of the boiler as is common practice with such a large boiler, but was reinforced by a double tee ring. The top head was braced to the side of the boiler shell by seventeen 1⅛-inch diagonal stays, each being riveted to the shell by two rivets, the flat surface being 7/16 inch thick by 2 inches wide. The other end of each brace was fastened to two angle irons riveted to the top head, a bolt securing the yoke end to the angle irons. The top end of the cone sheet was riveted to the flared-out end of the flange of the top sheet with ¾-inch rivets having a pitch of 2 inches. While these rivets were made with a good head on one side of the joint, the tail-end head was altogether too flat.

The explosion occurred immediately after the opening of the throttle valve in the steam pipe leading to the engine. The safety valve had blown off at a pressure of 93 pounds a few moments before the explosion occurred, and the engineer had just started the engine.

From all indications it would appear that first all of the diagonal braces from the top head to the side of the boiler gave way at the inner rivet holes, and as all of the breaks show bright metal, it is evident that an excessive pressure was exerted on them at the time of fracture.

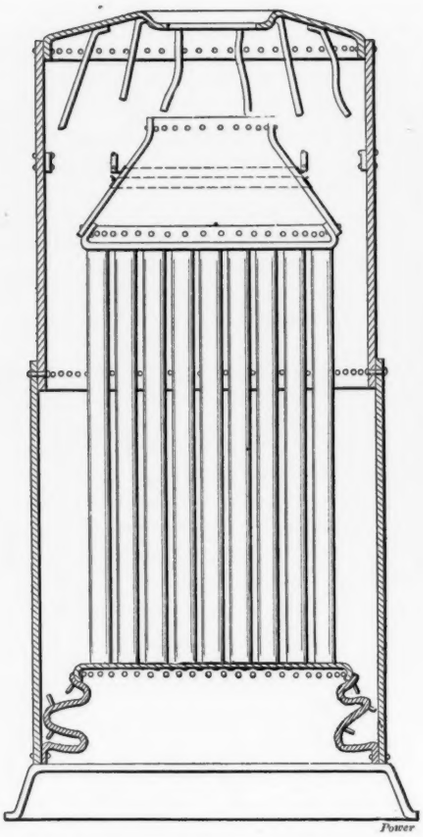


FIG. 1. SECTIONAL VIEW OF BOILER

These seventeen braces were separated at the point of fracture 2¼ inches.

By referring to Fig. 1, which is a sectional drawing of the boiler, showing it in about the condition it was found after the explosion, it may be seen that the fire-box sheet was crimped in a most peculiar manner. This is also shown in Fig. 2, and Fig. 3 shows a portion of the fire sheet forced out of the furnace door.

FIG. 3. PORTION OF FIRE SHEET FORCED OUT THROUGH FURNACE DOOR

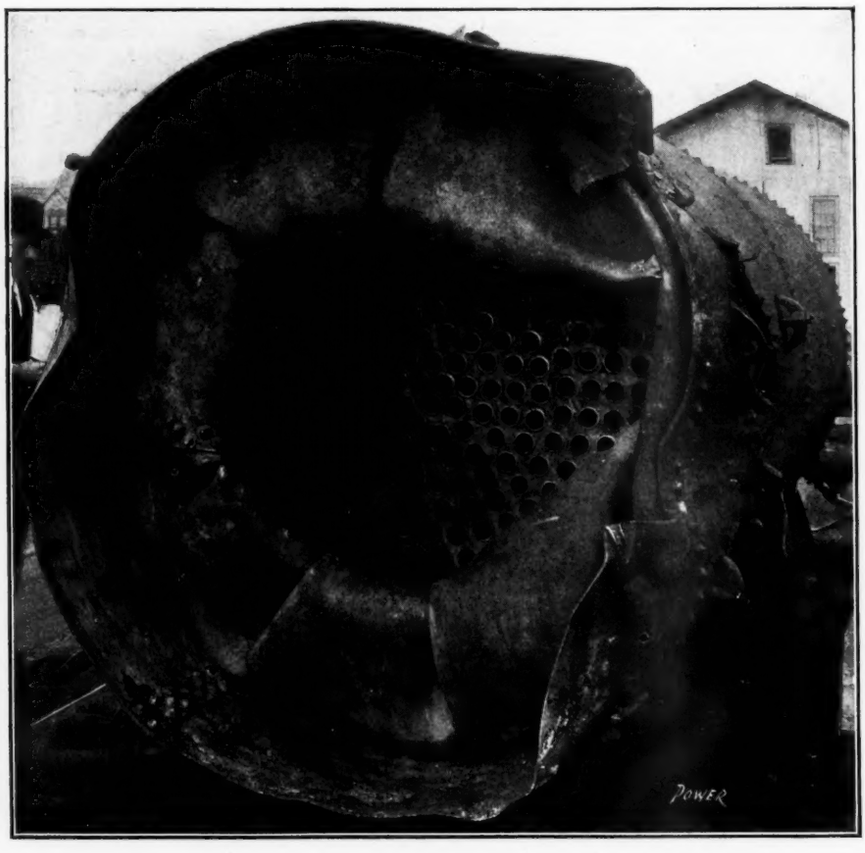


FIG. 2. BOTTOM OF BOILER, SHOWING CONDITION OF FIRE SHEETS

Fig. 4 shows that the flat top head has been drawn into the boiler several inches.

When the seventeen diagonal stays parted, the pressure in the boiler forced the top head outward, and with the giving of the head the cone section of the boiler, tubes and tube sheets were all forced toward the bottom of the boiler. This had the effect of causing the bent plate at the bottom of the fire sheet where it was riveted to the outer shell to straighten in its attempt to follow the tube sheets, and in so doing broke the staybolts, of which there were three rows. When the staybolts gave way (at the outer shell, at which point they were corroded to a scant ⅞ inch), the pressure began to force the tube sheets down, and in so doing crimped the fire sheet, in the manner shown in Fig. 2. While this action was taking place the top head was being drawn in, as the rivets in the joint of the cone and flange of the top head did not part until the fire sheet had crimped to such an extent that the smaller heads of the rivets in the top joint unbuttoned. When this occurred the boiler exploded.

The heads of the rivets that unbuttoned were not fractured or sheared but turned back over themselves, while the rivet holes in the cone piece were elongated. The rivets remained in the turned-in flange of the top head. The condition of the fire sheet showed that a remarkable piece of plate had been used in its construction, for, with the exception of two or three short cracks extending from the

FIG. 4. FLAT TOP HEAD DRAWN INTO BOILER

staybolt holes, there is not a sign of fracture.

Another feature of interest is that the tube sheets do not show the least signs of having been through any unusual experience. They are apparently as flat as when first put in the boiler, and although both heads and tubes have been shoved down into the boiler shell a matter of about 20 inches, only three tubes were but partly drawn from the lower tube sheet, while the upper tube sheet and tubes remained intact.

The boiler was first put into service nineteen years ago, and had recently been retubed. It was insured by the Hartford Steam Boiler Insurance and Inspection Company.

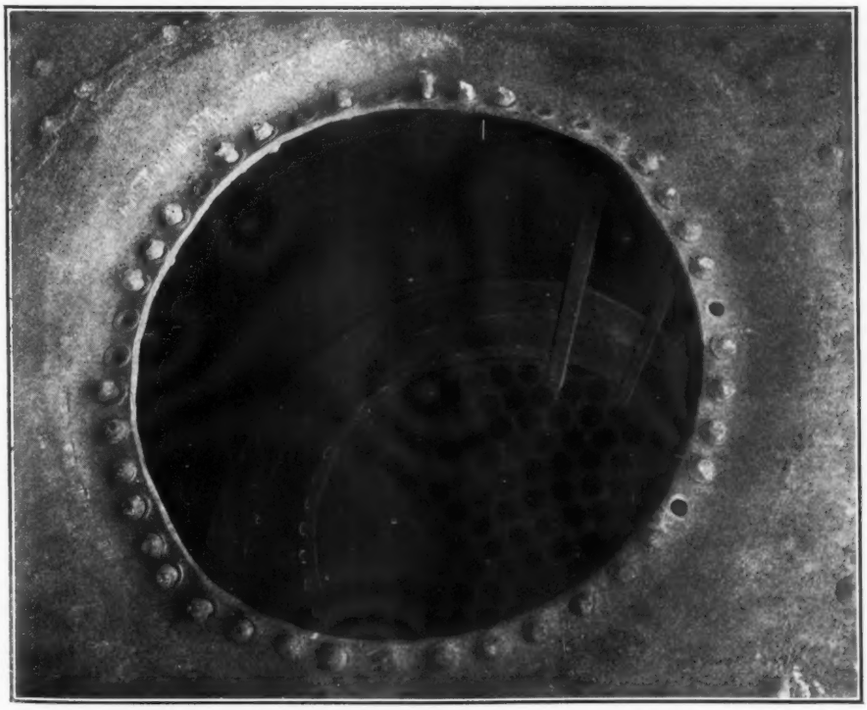


FIG. 5. LOOKING INTO TOP OF BOILER

Jersey State N. A. S. E. Convention

The annual convention of the New Jersey State association of the National Association of Stationary Engineers was held in Jersey City, June 4 and 5. The convention was called to order on Saturday afternoon by Frank A. La Pointe, chairman of the local committee, who introduced several prominent speakers who made appropriate and interesting addresses. At the close of the preliminary exercises the meeting was placed in charge of State President Arthur L. Case. Many important measures were discussed, and considerable business conducive to the welfare of the organization was transacted. The several necessary committees were appointed, and at the close of the session the following State officers were elected: Edward Sears, president; William Krauss, vice-president; John J. Reddy, secretary; James J. Durkin, treasurer; Philip Tully, conductor; Fred Arner, doorkeeper; A. L. Case, State deputy president. The officers were installed by National President William J. Reynolds.

The delegates and friends visited places of interest about the city, including an inspection of the new county court house. The leading feature of entertainment was a banquet at Teutonia hall, on Saturday night, on which occasion the following addresses were listened to: The police commissioner welcomed the convention to Jersey City; Judge Robert Cary spoke eloquently of "Hudson County"; Past President Herbert E. Stone's toast, "The N. A. S. E.," was well received; Fred L. Johnson, of POWER, was interesting in his talk on the "Responsibility of the Engineer"; Police Commissioner Theodore L. Burck gave good advice in his remarks on "Coöperation and its Advantages"; Edward L. Murphy spoke of the merit of "Public School Engineers"; National President William J. Reynolds paid a tribute to the National Association of Stationary Engineers.

Interspersed between the speaking were songs, recitations and stories by Joseph McKenna, Frank Corbett, William Murray and Jack Armour. The next annual meeting will be held at Newark, N. J.

Among the exhibitors represented were Greene, Tweed & Co., Manning, Maxwell & Moore, Dearborn Drug and Chemical Works, Keystone Lubricating Company, The Lunkenheimer Company, Crandall Packing Company, Donegan & Swift, McLeod & Henry Company, Garlock Packing Company, POWER AND THE ENGINEER, C. Yingling & Son, Paul L. Crowe, Ohio Grease Lubricant Company, Ashton Valve Company, Clement Restein Company, Borne, Scrymser Company, Henry Johnson Company, Watson & McDaniel Company, Jenkins Brothers, James L. Robertson & Sons, *Practical Engineer*, Poole Manufacturing Company, The William Powell Company.

Inquiries of General Interest

Speed Indicator

How can an apparatus be designed which will show the variations in the speed of a waterwheel shaft? I do not wish to regulate the speed, but simply be able to see whether it runs faster or slower at one time than another.

M. B. J.

The figure shows diagrammatically an apparatus for determining speed at any instant. It represents an ordinary flyball governor driven by a quarter-turn belt or otherwise. The centrifugal force due to normal speed raises the balls to the position $B\,B$, an increase to position $B_1\,B_1$ and a decrease to position $B_2\,B_2$.

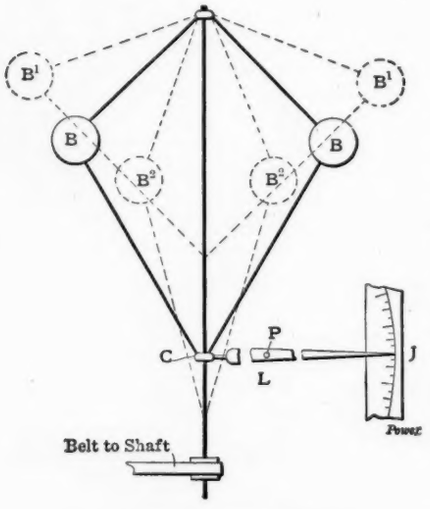


DIAGRAM OF SPEED INDICATOR

The rise or fall of the collar C connected to the balls is communicated to the short end of a long, light, rigid lever L balanced on the pivot P. The short end of the lever should be five to ten times the vertical movement of the collar C. The long end of the lever should be three to five times the distance $P\,C$.

A scale can be laid off on the index for different known speeds of the generator.

For simply indicating the period of fluctuations, an arbitrary scale will be sufficient and will show the time required for recovery of normal speed.

A graphical representation can be made by causing the end J to carry a pencil across a strip of paper wrapped around a drum driven by a clockwork; or by drawing a chart at a known velocity across the path of the tracing pencil.

More delicate though more intricate apparatus may be devised for determining the time of "oscillation" of the speed, but careful observations of the simpler apparatus, such as described, should answer every practical purpose.

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Measuring Clearance

What would be the quickest way to measure the clearance in either end of the cylinder of an engine?

M. M.

The quickest way and the only way to get it accurately without taking out the piston is to disconnect the connecting rod from either the crank or crosshead pin, move the piston until it strikes one head, mark the position of some point on the crosshead on the guide, then move the piston to the other end of the cylinder until it strikes the head and mark this position of the point on the crosshead on the guide. The distance between the marks on the guides minus the stroke of the engine is the total clearance, which should be divided equally between both ends of the cylinder.

Preheating Fuel Gas

We are using natural gas under our two 72-inch by 18-foot boilers. The 4-inch header, to which are attached 12 burners, is over the fire doors. Will it be safe and economize gas by running a steam line through the header in order to raise the temperature of the gas?

F. W. O.

It will be safe enough to heat the gas in the way described or in any other way, but there would be no economy in using steam made by the gas to heat it for the steam could give to the gas no more heat than the gas put into it. In fact, there would be a slight loss. If the air necessary to burn the gas could be heated without costing anything, there would be a gain.

Ringing a Bell from a Lighting Circuit

How can I ring a bell from a 110-volt lighting circuit if the magnet requires only 3 or 4 volts?

F. M. P.

Connect it in series with a 110-volt incandescent lamp, using a 16-candlepower lamp if ½ ampere is enough current, a 24-candlepower lamp if you need about ¾ ampere, or a 32-candlepower lamp if the magnet requires about an ampere.

Detection of Leakage Blowoff

Explain the detection of a leaking blowoff valve other than by feeling the valve or blowoff pipe for heat where the end of the pipe is concealed from view.

K. H. M.

Water escaping under pressure through a small orifice will make a slight noise which may be detected by holding one end of a short piece of wire rod about the size of a pencil on the blowoff and the other between the teeth, or by using the engineer's stethoscope.

Draft in Chimney

What makes a chimney draw?

B. A. T.

Chimney draft depends on the fact that the furnace gases have a higher temperature and are consequently lighter than the outside air at ordinary temperatures. The pressure within the chimney is therefore slightly less than the pressure of the outside air and there is a flow from the region of higher pressure to the lower, the air by its greater weight forcing its way through the furnace to the chimney.

Banking Fire

If called upon to stop the engine while there was a heavy fire in the furnace, how should I treat the fire?

C. L. S.

Cover the fire with coal and close the damper. There should be enough coal put on the fire to prevent the generation of heat. Heat from the brick would probably make some steam and blow the safety valve, but a little feed water from the pump would prevent excessive blowing.

Cushion in Duplex Pumps

How does a duplex pump get steam to cushion the moving parts at the end of the stroke?

A. C. G.

As the piston approaches the end of the stroke it covers the cylinder end of the exhaust port, preventing the escape of exhaust steam from the cylinder except by the way of the steam port and the cushion valve. The steam thus caught is compressed and prevents the piston from striking the cylinder head.

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. and Treas. ROB'T MCKEAN, Sec'y.
505 Pearl Street, New York.
150 Michigan Avenue, Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1909 *we printed and circulated* 1,875,000 *copies of* POWER.

Our circulation for May 1910, *was* 177,500.

June 7..... 35,000
June 14..... 35,000

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents PAGE

A Small Modern Lighting Plant..... 1062
Side Feed Automatic Stokers..... 1064
Influence of Fire Cracks..... 1067
Friction Loss in Surface Condensers... 1068
Dick Darrow's Daring Deed..... 1069
Air Compressor Cylinder Ratios..... 1070
The Proper Fitting of Engine Cranks.. 1072
Cheating the Electric Meter..... 1074
National Electric Light Convention.... 1075
Gas Power and Central Station..... 1079
Simple Adaptation of a Gas Producer for Heating..... 1080
The Rating of Gas Producers..... 1080
Steam and Gas Power Fuel Economy.. 1081
What Broke the Cylinders Off?..... 1081
Practical Letters:
Too Much Compression....Repairing a Broken Main Bearing....Device for Saving Oil....An Unexplained Break....City Council Engineering ....Second-Hand Boilers .... System for Treating Hard Water....A Novel Pump Governor....Boring a Pump by Hand....A Makeshift Oiling Device.....1082-1085
Discussion Letters:
Perpetual Motion .... Oil Grooves in Bearings....Position of Throttle ....Buying Coal on a Horsepower Basis....Boiler Room Ventilation ....Capacity of Deep-well Pumps .... Putting It up to the "Old Man" .... Double Expansion Engine 1086-1089
A. S. M. E. Convention at Atlantic City 1090
Vertical Boiler on Drydock Explodes... 1093
Editorials 1096-1097

Power and The Engineer

Editorial

Units of Boiler and Producer Capacity

The interesting historical resumé presented to the American Society of Mechanical Engineers in Professor Magruder's paper upon Two proposed Units of Power and the discussion thereon presents the different phases of the effort of a body of growingly scientific men to get away from the archaic unit by which James Watt expressed the capacity of his engine in terms of the hay-fed source of energy which it displaced.

The term "horsepower" is an anomaly as applied to a boiler or a gas producer. Intelligent practitioners are disregarding it more and more, and burning and selling boilers by the square foot of heating surface or by their capacity to turn water into steam, without any mention of or reference to the term, and yet the only official definition which the profession has of boiler capacity includes and is based upon the Centennial standard for boiler horsepower set by the committee of judges of the Centennial exposition in 1876.

It would have been a bold, far-sighted move if Messrs. Charles E. Emery, Charles T. Porter and Joseph Belknap, the Committee on Boiler Trials of the Judges of Group XX to whom was delegated the testing of the boilers at the Centennial exposition, had broken away from this unscientific unit and expressed the capacities of the boilers in terms of the heat which they absorbed and delivered in their outflowing steam without reference to their "horsepower."

If they had supposed that their determination was to have anything more than a temporary significance; if they had suspected that they were setting a standard which should govern the practice of the profession for a century to come, they would probably have foreseen how completely the conditions, then common, of seventy pounds pressure, one-hundred-degree feed and thirty pounds consumption would be outgrown. But their task as they saw it was to see how nearly the boilers submitted came to supplying steam to generate the horsepower which their builders claimed for them and with what efficiency and they defined the horsepower in the light of the then present conditions and did it well, setting a precedent in the way of competitive tests that no exposition since has to our knowledge improved upon or approached.

When the committee appointed by the American Society of Mechanical Engineers to prepare a code for boiler tests reported, and by the way, this was at Atlantic City too, twenty-five years ago, they had another chance to discard the horsepower, but it had become so firmly rooted that they balked. They were afraid of making their report so scientific that nobody would use it.

The evaporation of thirty pounds of water from water of one hundred degrees temperature into steam of seventy pounds pressure, the present unit of power, represents the absorption of 33,305 B.t.u., as given by the Centennial judges and by the American Society of Mechanical Engineers' committee of 1884; 33,317 according to the report of the revision committee of 1877, 33,454.7 by the latest edition of Peabody's and 33,478.8 by the new Marks-Davis steam tables.

Professor Magruder's suggestion to make the unit of boiler capacity the ability to transmit 33,000 B.t.u. per hour is not new; but the engineering world is probably more ready to receive it than it was a quarter of a century back. The professor also suggests that the unit of capacity of a gas producer be 10,000 B.t.u. of heat energy delivered per hour. He suggests calling these units respectively a "boiler power" and a "gas power." To be consistent he should call the first a "steam power." But is the term a measure of power at all? H. G. Stott suggested that the value be 34,120, ten times the equivalent of the kilowatt in B.t.u. per hour, and that it be called the "Thurston" in honor of the late Dr. Robert W.

Whatever its value and whatever its name, there should be some rational unit agreed upon for the capacity of the apparatus whose function it is to furnish the working fluid to a heat engine; and it is not clear why there should be any difference in the unit whether the fluid be steam or gas. One unit simple to remember and to work with and which will not change with the weather should be selected for all such apparatus, and we hope that the next committee that revises the boiler rules will establish such a unit and forget the horsepower. It will make no confusion. Those who appreciate the need and use of such a unit will use it, and the users of "horsepower" will be left to a search of traditions to see what it means when it is called into question.

The Ultimate Ownership of Water Powers

The New York State Water Supply Commission has worked out a general plan for taking land, constructing reservoirs and otherwise executing the more costly part of the water-power developments at the expense of the State, to be met by the issue of bonds to run for fifty years. The interests involved now want to know who will own the plant at the end of the fifty years. The commission and State authorities claim that the ownership should remain with the State. The water-power interests oppose this, claiming that the ownership of the reservoirs and other works should rest with them since in their leases they will have refunded at the end of fifty years all the money that the State advanced. In this position they overlook the basic fact that it is not they, the lesees, who will have been paying these bonds and the interest thereon but the users of the power developed, to whom they will have passed the charge along and who will in turn pass it along to the ultimate consumer. It is the people who will pay those bonds and a profit to the lessees besides, and if the latter are unable to settle down to the enjoyment of a fair amount of remuneration for their operation of the works without insisting upon appropriating the peoples' inheritance in their natural resources and their improvements of them just because they had run them as lessees for the period of partial payments, they may wake up to the fact that they are an entirely unnecessary link in the chain; and find that the people can develop and operate their own resources without their intervention, interference or assistance.

Watching the Stack

Plants which burn bituminous coal all have, in the stack, an indicator which can be relied on to give fairly accurate readings of what is taking place in the furnace at any given moment. This indicator, if the plant is fortunate (or unfortunate?) enough to be located within the boundaries of a district having a smoke ordinance, is assiduously studied not only by the engineer himself, but by much interested smoke inspectors as well. In fact it is becoming no joke to run a bituminous coal-burning plant in a district in which rigid smoke regulations are enforced.

In many cases thousands of dollars have been spent on equipment in the effort to comply with smoke ordinances and still the fines do not entirely cease. After a company has invested what it considers a fair amount of money for smokeless equipment, and on top of that has stood for a number of hundred-dollar fines, it commences to be seriously up to the engineer to explain why the plant cannot be run without smoke. Every engineer knows that a trifling change in adjustment will sometimes mean the difference between success and failure, and how large a part intelligent attendance plays in smokeless operation. He knows also that attendants, however well meaning, are not, and cannot be made one hundred per cent. efficient, and there is, therefore, enough element of chance in even the best regulated boiler rooms, to keep the operator on the anxious seat.

This anxiety to prevent smoke, this placing of smokelessness even before efficiency, will frequently influence an engineer against installing many economical auxiliary devices which might increase the chances for efficient running but which might, also, complicate the plant and increase the possibilities for making smoke. It is realized that devices for attaining any desired end in a power plant are presumed to show a saving in steam or fuel, or maintain some set of conditions which will enable the plant to deliver a uniform output with a minimum of wear and tear and expense. But sometimes in attaining this end, some other set of conditions which, however, may not be so apparent, is disrupted, and when the latter contingency means the paying out of good money in the shape of a fine, it is thought best to forego the possible advantages of the added equipment.

In all works on combustion the importance of proper regulation of the fires to take care of varying conditions is emphasized. The draft must be regulated according to the amount of steam being used; the air supply must be varied with the amount of coal fed; all factors are interdependent, and when working together, make for economy. But when a damper regulator is attached to a boiler fitted with a mechanical stoker the combination becomes more complex than merely regulating the draft. If the steam goes up, the draft shuts off and the coal is burned at a decreased rate. The grates, however, are feeding coal as usual and the result is that fuel is fed to the furnace in excess of the requirements, and at the same time a limited supply of air is provided, so that there are all the elements necessary for making smoke. A little study will show that by further extending the influence of the damper regulator, so that instead of operating the damper alone, it is arranged to slow down the stoker engine also when the steam rises above a certain limit, and to do this before the damper closes, it might be expected that a varying load could be carried satisfactorily and without attracting the attention of the smoke observers. In the ordinary arrangement while the damper is taking care of the steam pressure, the slowing down of the stoker feed is left to the fireman, with the result that often not only smoke is made, but also the boiler blows off steam. This is undesirable and uneconomical.

By a little ingenuity many a damper regulator in antismoke districts which is now decorating the engine-room wall as a useless ornament, could be made to pay big dividends on its first cost.

Lend a Hand

If you are an operating engineer and want to see that vocation put more nearly upon a professional plane, if you want to see an Institute established which shall be to that vocation what the great national societies of civil, mechanical, mining and electrical engineers are to those professions; if you want to help make the school of experience into a college and to give to its graduates the prestige and recognition which the world accords to training and education, go to Room 609, in the United Societies building, 29 West Thirty-ninth street, New York, on Tuesday evening, June 21, and find out what the Institute of Operating Engineers is going to be. It will be a good chance too to see the building which is the engineering Mecca of America, the home of most of the large professional engineering societies and contains the most complete mechanical library in the country.

The Preliminary Organization of the Institute of Operating Engineers has established an office at room 609, in the United Societies' building, 29 West Twenty-ninth street, New York. The office will be open on Tuesday, Thursday and Saturday evenings and those who are interested to know more of the Institute, what it purposes to accomplish for the operating engineer and how it purposes to accomplish it, are invited to call.

One of the disgraces of this country is the total lack of Federal legislation in the matter of compulsory boiler inspection. The gravity of the situation may perhaps be slightly recognized when the destruction of life, limb and property in the United States resulting from boiler explosions is compared with that in Great Britain and Germany, where all boilers are under governmental supervision, and no time is lost in placing the responsibility for disaster where it belongs.

Past President and Honorary Secretary Hutton was much missed at the Atlantic City meeting of the mechanical engineers. It is the first meeting from which he has been absent since he became secretary of the society in 1883.

New Power House Equipment

Single's Automatic Engine Stop and Overload Controller

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

A Corliss engine governor is so designed that in case the governor belt breaks or the governor stops, steam is cut off from the cylinder. It is therefore necessary to provide means of holding the governor at its point of maximum cutoff when the engine is shut down. This is usually done by placing a pin or some other kind of rest under the parallel rod of the governor, which should be removed immediately after the engine is up to speed.

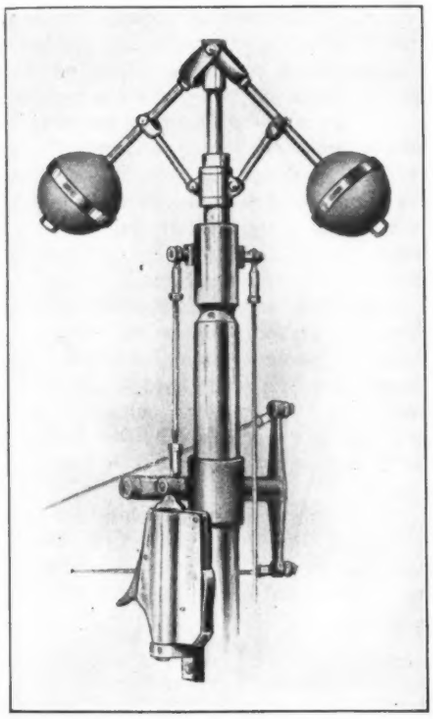


FIG. 1. STOP AND CONTROLLER ATTACHED TO CORLISS ENGINE GOVERNOR

When heavy overloads are met with the governor is liable to drop below the point of maximum cutoff, thereby bringing the safety device into action and shutting down the engine.

It is because of this condition that the engineer frequently leaves the stop pin or rest in place while the engine is running, in spite of the possibilities of disaster to the plant in the event of the governor belt breaking, or the stopping of the governor.

The Single automatic engine stop and overload controller was designed to guard against such conditions. It is shown attached under the parallel rod of the governor in Fig. 1, or under the crosshead of the governor in Figs. 2, 3, 4 and 5.

The engineer places the small lever or dog in position as shown in Fig. 2, just before shutting down the engine. When in this position the device acts the same as a stop pin or rest, holding the governor at its maximum point of cutoff. When the engine is gotten up to speed again, this lever drops out automatically as shown in Fig. 3, putting the engine governor in a safe position. In the event of the governor belt breaking or stopping of the governor, the entire weight of the governor coming down upon the device compresses it as shown in Fig. 5, allowing the governor to drop below its maximum cutoff, putting the safety cams in use and cutting off steam from the cylinder.

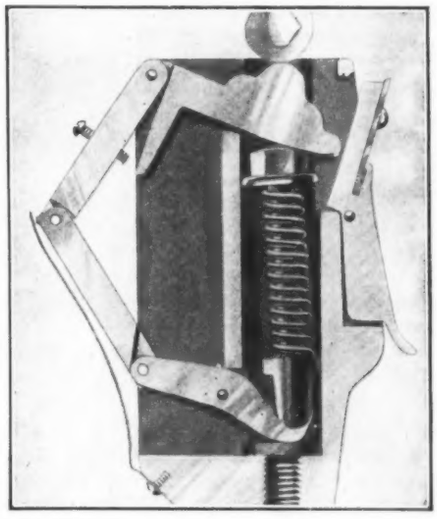
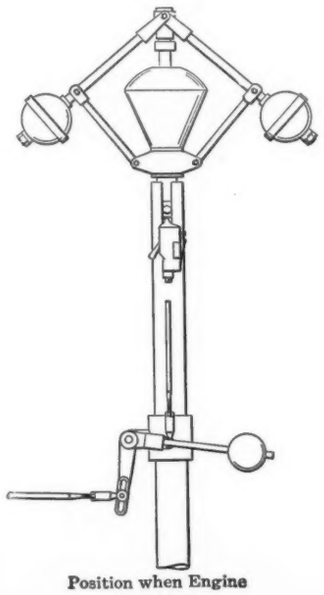
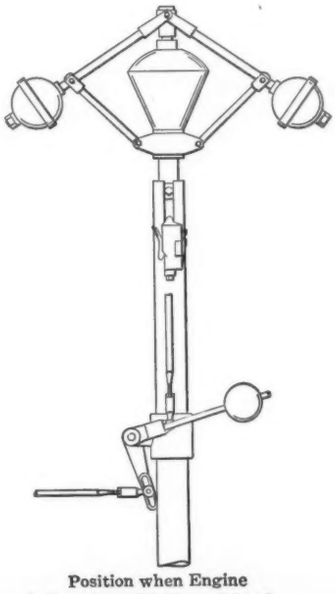


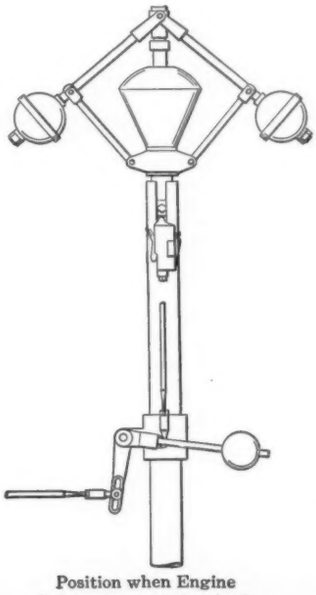
FIG. 6. SECTIONAL VIEW OF STOP AND OVERLOAD CONTROLLER



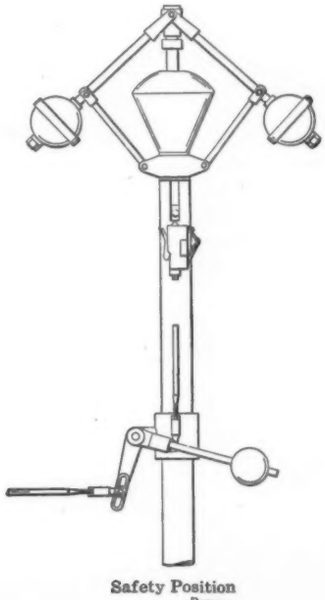
Position when Engine is at Rest
FIG. 2



Position when Engine is Running with Normal Load
FIG. 3



Position when Engine is Running with Overload
FIG. 4



Safety Position
FIG. 5

Power

The intelligent engineer in charge of engines subject to heavy overloads understands the danger in having the stop pin in his governor column, but is absolutely forced to do so by the condition of his load. To him the overload feature of this device will appear strongly, because with it he can carry his engine over peak loads sufficient to reduce the engine speed 25 per cent. and feel secure that in case of the breaking of the governor belt or the stopping of the governor, the governor will drop into the safety position.

This is accomplished by the adjusting coil spring shown in the sectional view, Fig. 6, so that it will carry without collapsing the weight due to the decrease in speed of the desired number of revolutions. Any further weight due to the governor belt breaking or the stopping of the governor will immediately collapse the spring, forcing out the toggle joint and cause the device to take the position shown in Fig. 5. This position of the governor will cause the safety cams to come into action and shut off the steam from the cylinder.

This engine stop and overload controller is said to be certain in operation, has direct and sure control over the engine, and can be fully depended upon to automatically stop the engine in case of emergency or accident.

This device can be attached to any Corliss engine governor within 30 minutes, and after being attached and set requires no further attention. It is manufactured by Oscar D. Dillman, Hamilton, Ohio.

Manistee Duplex Steam-valveless Pump

The Manistee Iron Works, Manistee, Mich., is bringing out a unique line of duplex steam-valveless pumps in all sizes and for all purposes. In this design, valve stems, rocker arms, links and similar connections are done away with entirely and there are no moving parts except the pistons and piston rods.

Fig. 1 shows four positions of the steam pistons and gives an idea of the construction of the cylinders. As indicated, the steam end consists of a pair of cylinders cast together, with inwardly projecting cylinder heads, over which the working pistons fit with a couple of cast-iron snap rings. The working ports are cast integral with the cylinders and their openings have a V-shaped section which allows a gradual distribution of steam as the pistons uncover the ports, thus starting the stroke gradually.

The pistons *X* alternately receive live steam on either side. The extensions of the pistons are fitted with snap rings at the head end of the cylinders and so arranged as to the position of the ports that at the proper time exhaust steam from the opposite working cylinder is admitted to the space at the end of the piston extension, which aids in producing movement to the pump piston. This produces a compound effect. In operation, each lower cylinder shown in Fig. 1 is really a valve, as it furnishes the initial movement to complete the cycle of operation. The port *A* is always a live-steam port, but the functions of the other ports marked *B*, *C* and *D* change from time to time, being at some parts of the stroke steam ports and at others exhaust ports. From the construction it is obvious that the pistons must complete their stroke before the function of the ports can be changed, which prevents short stroking of the pump under normal operating conditions. There is no operative dead center and it is said that the pump will run at slow or high speeds equally well.

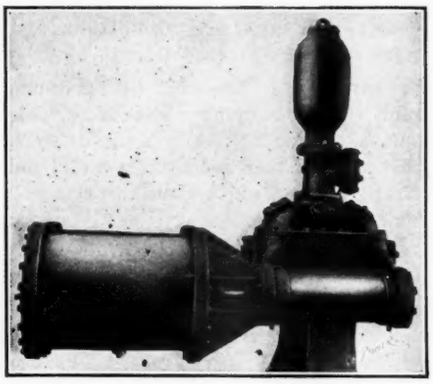


FIG. 2. MANISTEE DUPLEX STEAM-VALVELESS PUMP

Owing to the disposal of the ports and the method of exhausting from one working cylinder into the other, it has been found that the pump will not run away if the suction is lost and that there is always a cushion of steam to prevent the pistons from striking the cylinder heads.

Among the advantages claimed for this pump is that owing to its simplicity it can be entirely inclosed to exclude the dust and dirt of a boiler room or similar location and may be left for long periods without attention. It is also claimed that it will operate equally well either in a vertical or horizontal position. Being without valve stems, rocker arms or links, it is noiseless in operation and there is no opportunity to alter the valve setting or get into trouble by making changes in the adjustment.

Removable studs are furnished on the piston-rod glands, which greatly facilitate the operation of packing. The valve seats are of tobin bronze, pressed in place and ground and faced after being in position, with the valve springs so disposed as to tighten the valve studs while in operation.

Fig. 2 shows an 18 and 10 by 12-inch feed pump. It will be observed that handholes are provided on this pump, making either valve deck accessible without dismantling.

Test of Kewanee Pipe Unions

The exact number of times that any pipe joint can be disconnected and reconnected depends upon the particular circumstances, but a test recently made with Kewanee unions may be of general interest to union users.

According to the National Tube Company, Frick building, Pittsburg, Penn.,

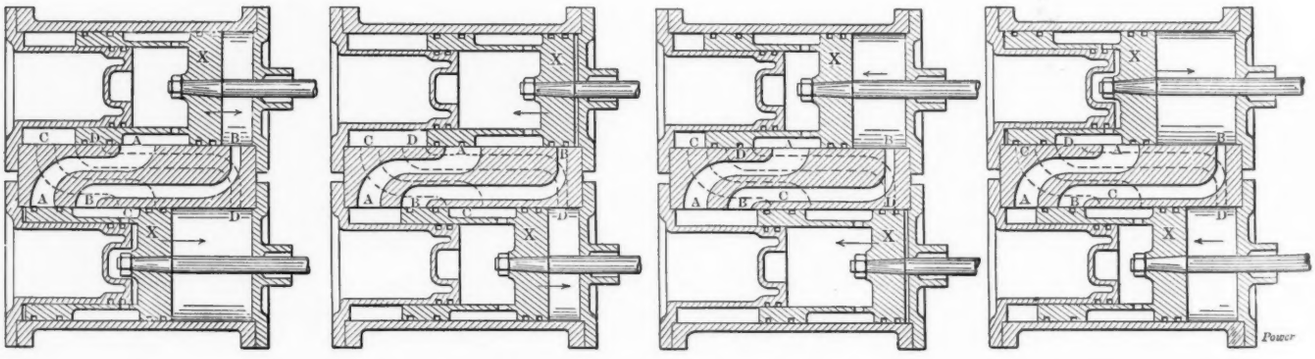


FIG. 1. SHOWING FOUR POSITIONS OF THE STEAM PISTONS

one 1-inch octagon and one 1½-inch round Kewanee union were taken from stock and tested in the following manner:

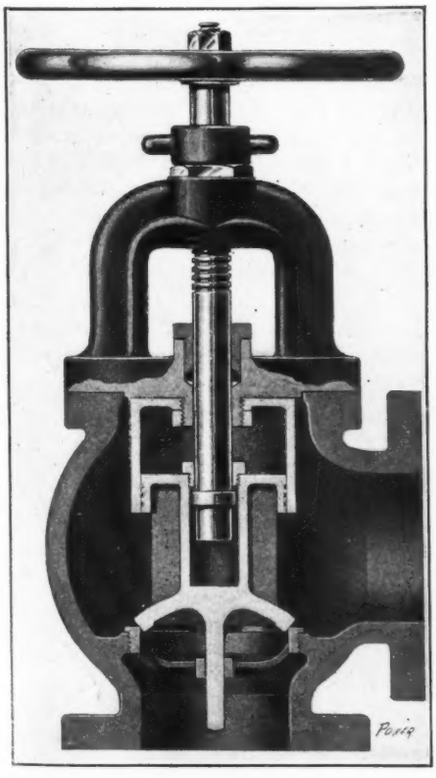
Each union was connected by means of a nipple, valve and nipple to a steam line. Into the other end of each union was screwed a nipple, on the outer end of which was another valve. The union connection was then tightened with an ordinary wrench, and steam pressure admitted through the valve next to the main; the outer valve was then opened to blow out the air and closed.

As the union did not leak steam, the pressure was shut off, the outer valve opened to release the steam and the union ring unscrewed entirely from the brass end of the union. This operation was repeated over 1000 times on each of the unions, and during the entire time neither union showed the slightest sign of leaking steam.

After the completion of this test, each union was taken to the union department, and subjected to the test given all new unions, that of 110 pounds air pressure under water. Each of these two unions was absolutely tight during this test, not the slightest bubble of air showing when the union was submerged and subjected to the air pressure.

Automatic Angle Stop and Check Valve

This valve is so constructed that it can be operated either as an automatic or a positive valve. The threads on the valve stem engage with those in the lock nut, shown at the top of the yoke, and when this lock nut is screwed down tight, the valve operates automatically. Should, at any time, the piston become stuck, the lock nut can be released, when the threads will come over the yoke and the combined piston and disk, which is attached to the stem by another lock nut, can be raised up and down. As soon as the valve is clean, the stem can be screwed through the yoke until the lock nut can be locked, when the valve again becomes automatic in action. This valve is made extra heavy for 250 pounds working pressure, in both steel and iron, by the Hughson Steam Specialty Company, 5021-23 State street, Chicago, Ill.

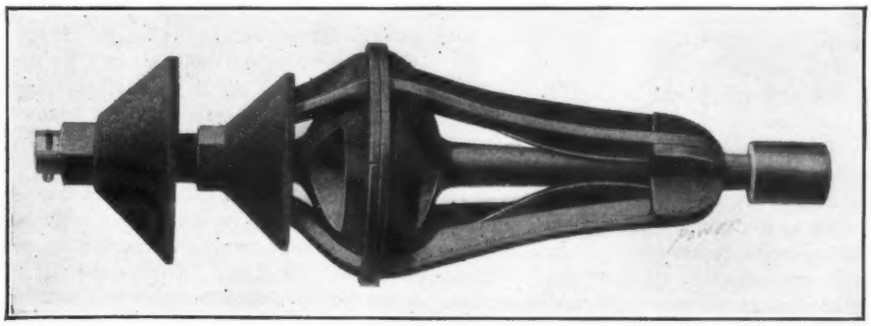


AUTOMATIC ANGLE STOP AND CHECK VALVE

Hull Tube Scraper

The illustration shows the Hull tube scraper, manufactured by A. A. Hull, 204 East Scott street, Knoxville, Tenn.

This scraper consists of a spindle on which are fitted the scraper arms and cone-shaped disks. The scraping plates consist of four half disks hung loose on a square central body of malleable iron. Forged-steel springs are fitted under the scraper arms, as shown. The scraping disks are casehardened, which prevents wearing away. The end of the scraper is fitted with a coupling, in which a suitable handle may be screwed.

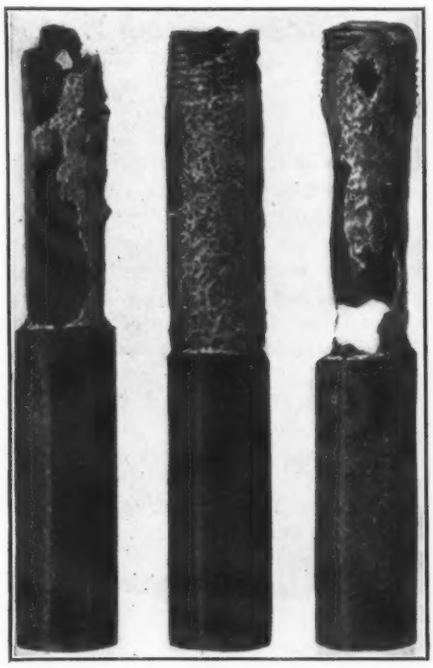


HULL TUBE SCRAPER

Highland Noncorrosive Coating

A compound that is claimed to effectually resist the corroding influence of acid in water is being marketed under the trade name of Highland noncorrosive coating. In the accompanying engraving are shown three nipples that were partly coated with this compound and then placed in water that was particularly bad. The views show clearly how the destructive action of the water was resisted by the coating.

In about 15 minutes after application, the coating dries with a hard glossy, enamel-like finish, which it is stated will not be eroded even by gritty mine water under heavy pressure nor at the elbows where the scouring action is more pronounced. The application of the coating is a quick and inexpensive operation. An ordinary brush like that used in painting is employed, or if the pipe is to be covered it may be dipped in a bath of the coating. No settling of any of the ingredients occurs so that it is not necessary to stir the mixture each time any is used. Daubing the threads of both members when making connections will produce a joint that should not rust or leak, it is said. The coating is made by the Highland Chemical Products Company, which is located at Connellsville, Penn.



PIPE, THE LOWER ENDS OF WHICH WERE TREATED WITH "HIGHLAND" COATING

According to *The Engineer*, London, a scheme for the construction of an elevated electric railway in Tokio is at present under consideration. It is proposed that there shall be two lines, one running from the east to the west of the city, and the other from the north to the south. The cost of construction of the projected lines is estimated at $11,700,000.

NEW PUBLICATIONS

THE UTILITY OF HIGHER EDUCATION. By R. T. Crane. Distributed through A. C. McClurg & Co., Chicago. 331 pages; 5x8; cloth. Price, $1.

This book is the outcome of some investigations by the author to determine the utility of all forms of higher education, by this term meaning all schooling above that of the grammar grades. As a matter of fact, however, the text deals principally with the subject of a college education, and takes up in order the academic or classical course, the technical and agricultural courses, and the professions. The whole attitude of the book is strongly adverse to all forms of higher education.

The method of procedure is to obtain by means of correspondence the opinions of various graduates, employers and educators, and then draw conclusions from their replies.

Without expressing an opinion upon the merits of the questions involved, we nevertheless feel that Mr. Crane's method of drawing conclusions warrants some friendly criticism, for although no doubt intending to be perfectly fair in his interpretations, yet he has allowed his prejudice to dominate him, as will be seen from the following extracts from the text:

The first few chapters deal with a form letter sent to the various college presidents, requesting numerous statistics which would tend to show whether their graduates were making a success. But owing to the fact that practically none of the colleges had records in the form as requested, most of the presidents replied in general terms and expressed their own views upon the subject. We agree with Mr. Crane in not attaching much importance to these opinions, as there was a possibility of their being biased; but at the same time we cannot sanction his conclusion, for he takes advantage of the lack of statistics by stating that it is a positive indication that the graduates are not making a success, and proceeds to denounce the colleges in rather strong terms.

Next, he deals with a form letter sent to some 1593 graduates, who have been out about seven years. Of these only 550 replied to his questions. Of these he casts aside 490, with the mere mention that they do not come within the scope of the investigation. Of the remainder only seven state that they believe a college education to have been of no advantage to them. It is upon the opinions of these seven, out of 1593, that Mr. Crane proceeds to pass judgment.

Out of 100 letters to business men, he gives the replies of 41, six of whom state that they are opposed to college men; ten have had no experience with college men; ten give no preference one way or another; and fifteen state positively that they favor college men. Again Mr. Crane takes refuge under the fact that these employers have not answered all his questions in the form desired, and proceeds to draw his conclusions upon the strength of the six unfavorable opinions. A sample of his reasoning is as follows:

W. F. Merrill, first vice-president of the New York, New Haven and Hartford Railroad, states that in his opinion college men make better help than men of the same caliber who have not had the advantage of a college education, and that they advance quicker. Commenting upon this, Mr. Crane concludes that Mr. Merrill is mistaken, owing to the fact that out of 900 station agents along the lines of the railroad, none are college men.

Of a technical education Mr. Crane takes the same stand. He cites the cases of several prominent engineers of 25 or 30 years ago, as striking examples of nontechnically trained men, and points out as monumental pieces of engineering, the Erie canal, the Brooklyn drydock and the Morman temple. At the same time he belittles the engineering features of the new Pennsylvania Railroad extension into New York City.

He severely criticizes the policies of the Westinghouse Electric and Manufacturing Company, the General Electric Company and the Pennsylvania Railroad for their preference to technically trained men, and takes issue with the heads of departments, whom he accuses of not knowing what they are talking about.

It might further be remarked that he has failed to give interviews with any of the large purely engineering or construction firms, he having confined his inquiries to the manufacturing and operating lines.

It would be interesting to know what experience Mr. Crane has had in railroading or electrical engineering, for some of his statements along these lines do not show the slightest conception of engineering problems.

The medical profession also comes in for strong criticism, and he endeavors to score a point against the profession by emphasizing the fact of several frauds, but evidently forgets, or does not care to take notice of, the frauds that have recently been exposed in high financial circles.

He places the average cost of a technical education at $5000, which, to say the least, is misleading. A significant fact is that he does not cite a single case of failure, nor does he, as we should suppose, take the cases of a given number of boys, starting with equal opportunities, half of whom have had the advantage of a higher education, and the other half who have not had any schooling above the grammar grade, and proceed to compare their relative success.

Institute of Operating Engineers Will Meet

There will be a meeting to explain the aims, purposes and proposed methods of the Institute of Operating Engineers at the headquarters of the provisional organization, Room 609, Engineering Societies building, 29 West Thirty-ninth street, New York, on Tuesday evening, June 21, at 8 o'clock. All who are interested to know more of this movement for the betterment of the operating engineer are invited to be present.

Detroit Boiler Ordinance

The boiler ordinance for the city of Detroit which has been under consideration for some time has finally been passed in favor of the straight Massachusetts rules by a unanimous vote of the Common Council. There has been a great deal of study and investigation given this subject by those in charge of the matter and a great deal of credit is due the Common Council of Detroit for taking the course it has and lifting the work of boiler inspection and operation from the rut common to municipalities.

The example set by Detroit will be a great benefit to other cities maintaining boiler inspection or contemplating such measures. Thomas E. Glinnan, president of the Council, Alderman William Gutman, chairman of the committee, and Alderman Walsh, who is a stationary engineer, deserve much credit for their efforts in promoting public safety.

PERSONAL

N. A. Carle desires to announce that he has opened an engineering office at No. 510 Central building, Seattle, Wash., and offers his services for consulting and constructing work in mechanical, electrical and mining engineering.

On Friday evening, May 27, J. C. Jurgensen was presented with the handsome medal shown in the accompanying

illustration by the Relief and Educational Society, consisting of members belonging to the engineering department of the St.

Regis hotel. Mr. Jurgensen formerly founded this society. At the same time R. M. Haan, proprietor of the St. Regis hotel, was presented with a similar medal. These medals are tokens of esteem given only to honorary members.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c each Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

GAS ENGINE. Raymond J. Leach, Seekonk, Mass. 958,881.

ROTARY ENGINE. George F. Moors, Mount Vernon, Ill. 958,885.

GAS ENGINE. John V. Rice, Jr., Bordentown, N. J., assignor to Rice Gas Engine Company, Bordentown, N. J., a Corporation of New Jersey. 958,975.

RECIPROCATING GAS ENGINE. Walter Miles, Leedom, Colton, Cal. 959,019.

INTERNAL COMBUSTION ENGINE. Olin A. Stranahan, New York, N. Y. 959,084.

ROTARY ENGINE. Louis Lazare Auguste Seguin, Paris, France, assignor to Societe des Moteurs Gnome, Paris, France. 959,172.

WAVE POWER. Samuel B. Goff, Camden, N. J. 959,214.

BOILERS, FURNACES AND GAS PRODUCERS

FURNACE. William H. Perkins, Ottawa, Ontario, Canada. 958,763.

HYDROCARBON BURNER. Burt L. Worthen, Tucson, Ariz., assignor, by direct and mesne assignments to the Kemp Hydro-Carbon Furnace Company, a Corporation of New York. 958,789.

OIL-GAS GENERATOR AND BURNER. George Drummond, Los Angeles, Cal. 958,861.

FURNACE. John M. Brooks, Baltimore, Md., assignor of one-half to Edwin M. Adams, Baltimore, Md. 958,903.

HYDROCARBON BURNER. John E. Walling and Andy Olson, Portland, Oregon. 958,947.

FORCED-DRAFT FURNACE GRATE. William Howard Palmer, Fort Scott, Kan. 958,971.

HYDROCARBON BURNER. Oscar Fordice, Los Angeles, Cal. 958,999.

FURNACE. James A. Penney, McKeesport, Penn. 959,253.

OIL BURNER. Thomas W. Hunter, Petaluma, Cal. 959,347.

OIL BURNER. Arthur H. Light, Los Angeles, Cal., assignor to A. H. Light Engineering Company, Los Angeles, Cal., a Corporation of Arizona. 959,363.

OIL BURNER. Arthur H. Light, Los Angeles, Cal., assignor to A. H. Light Engineering Company, Los Angeles, Cal., a Corporation of Arizona. 959,364.

VAPOR BURNER. Azro H. Waite, El Paso, Ill. 959,410.

POWER PLANT AUXILIARIES AND APPLIANCES

VALVE. George M. Bard, Chicago, Ill., assignor to Norwall Manufacturing Company, Chicago, Ill., a Corporation of Illinois. 958,716.

CENTRIFUGAL PUMP. Harry A. Prindle, Philadelphia, Penn. 958,765.

CENTRIFUGAL PUMP. William K. Richardson, Leavenworth, Kan. 958,768.

PROCESS OR METHOD OF PURIFYING OR CLARIFYING WATER. William K. Richardson, Leavenworth, Kan. 958,769.

CENTRIFUGAL WATER PURIFIER. William K. Richardson, Leavenworth, Kan. 958,770.

WATER-SOFTENING APPARATUS. Hezekiah Russell, Marion, Ohio. 958,831.

WATER-SOFTENING APPARATUS. Hezekiah Russell, Dayton, Ohio. 958,832.

WATER HEATER AND PURIFIER. Henry White, Cleveland, Ohio, assignor of one-third to Winfield S. Parr, Lakewood, Ohio. 958,845.

CARBURETER. James W. Snedeker, Adrian, Mich. 958,897.

ENGINE CYLINDER. George J. Bryen, Duquesne, Penn. 958,905.

TIMER AND DISTRIBUTER. Charles Cuno, Meriden, Conn., assignor to the Connecticut Telephone and Electric Company, Incorporated, Meriden, Conn., a Corporation of Connecticut. 958,908.

DETACHABLE BOILER FLUE. Julian F. Drake, Tracy, Minn. 958,910.

FORCE-FEED LUBRICATOR. Harry Le Roy Davis, Seneca Falls, N. Y. 958,994.

GREASE CUP. James G. Matheny, Terre Haute, Ind. 959,023.

CARBURETER. William Ottaway, Aurora, Ill., assignor to Aurora Automatic Machinery Company, Aurora, Ill., a Corporation of Illinois. 959,066.

STARTING MECHANISM FOR EXPLOSIVE ENGINES. Charles E. Reddig, Hartford, Conn. 959,070.

CENTRIFUGAL PUMP. Peter J. Wickblom, Bishop Hill, Ill. 959,089.

END CONNECTION FOR METALLIC HOSE PIPES. Emil Witzenmann, Pforzheim, Germany. 959,187.

FUSE PLUG. William F. Duckwitz, Cleveland, Ohio. 959,208.

HOSE COUPLING. Walter W. Keys, Yonkers, N. Y. 959,226.

AUTOMATIC LUBRICATOR. John William Shafer, Chicago, Ill., assignor of one-half to Frank Young, Chicago, Ill. 959,267.

STEAM-, AIR- AND WATER-TRAP VALVE. John E. Boegen, Berwyn, Ill., assignor to Charles P. Monash, Chicago, Ill. 959,297.

VALVE MECHANISM FOR ENGINES. John W. Guthrie, Falls Creek, Penn. 959,339.

GAS-ENGINE VALVE TIMER. Thomas P. Huden, North Bend, Ore. 959,345.

VALVE. Eugene D. Jefferson, Lowell, Mass. 959,349.

CARBURETING APPARATUS. Gustaf Johnson, Chicago, Ill. 959,350.

PIPE-END CLOSURE. Marion W. Pitner, Chicago, Ill. 959,385.

ELECTRICAL INVENTIONS AND APPLICATIONS

ELECTRIC CAUTERY. William Meyer, Chicago, Ill. 958,753.

HIGH-FREQUENCY MAGNETO. Theodore M. Mueller, New York, N. Y. 958,754.

ELECTRIC MELTING AND REFINING FURNACE. Hans Nathusius, Friedenshutte, near Morgenroth, Germany. 958,757.

MAGNETIC SWITCH. James J. Wood, Fort Wayne, Ind. 958,788.

MOTOR STARTER. Fletcher D. Hallock, Pittsburg, Penn., assignor to the Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 958,804.

RHEOSTATIC CONTROLLER FOR ELECTRIC MOTORS. Fletcher D. Hallock, Pittsburg, Penn., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 958,805.

REGULATING RHEOSTAT. Fletcher D. Hallock, Pittsburg, Penn., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 958,806.

ELECTRIC ARC LAMP. Leon W. Pullen, Camden, N. J., assignor, by mesne assignments, to Waldron Clark Manufacturing Company, a Corporation of New York. 958,827.

ARC LAMP. Leon W. Pullen, Camden, N. J., assignor, by mesne assignments, to Waldron Clark Manufacturing Company, a Corporation of New York. 958,828.

ELECTRIC FURNACE. Harold A. Danne, Clarkesburg, W. Va. 958,855.

RHEOSTAT. Fletcher D. Hallock, Pittsburg, Penn., assignor, by mesne assignments, to Westinghouse Electric and Manufacturing Company, East Pittsburg, Penn., a Corporation of Pennsylvania. 958,869.

ELECTRIC ARC LAMP. Heinrich Beck, Frankfort-on-the-Main, Germany, assignor to Beck Flaming Lamp Company, Canton, N. Y., a Corporation of New York. 959,045.

METAL FILAMENT LAMP. Carl Rumenapp, Augsburg, Germany. 959,075.

MAGNETO ELECTRIC GENERATOR. Benjamin P. Remy and Frank I. Remy, Anderson, Ind., assignors to Remy Electric Company, Anderson, Ind., a Corporation. 959,166.

TOOLS

WRENCH. Frederice Schneider, Velva, N. D. 959,029.

WRENCH. William Ducharme, Johnstown, Penn 959,322.

QUICK ADJUSTING WRENCH. Robert L. Walters, Lavonia, Ga. 959,436.

ELECTRIC-SIGNALING APPARATUS. Louis W. Carroll, Anamosa, Iowa. 958,224.

ELECTRIC MOTOR. Charles E. Avery, Jersey City, N. J., assignor to Manhattan Electrical Supply Company, a Corporation of New Jersey. 958,354.

MOTOR-CONTROLLING DEVICE. George T. Eagar, Ballston Spa, N. Y., assignor to General Electric Company, a Corporation of New York. 958,380.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff. Denver, Colo.; sec. and treas., Frank M. Tait. Association York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U .S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City. Next semi-annual meeting, St. Louis, Mo., June 30 and July 1, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August 2-5, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. E. Brown; sec., Harry D. Vaught, 95 Liberty street, New York.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power and the Engineer.

"Yes, siree! Men who can write snappy, catchy advertising are born and not made," said the talkative salesman, shifting the tilt of his chair to a still more comfortable angle and emitting clouds of smoke from his glowing Perfecto.

"They're the king pin hot air geniuses of the Twentieth Century and no mistake about it."

Which remark leads to a brief vivisection—with a word of philosophizing on the side—of the Mental Processes which are responsible for the matter that covers the advertising pages of a publication in the power field.

Pretty far away from subjects of interest to the man who *reads* the ads.?

No, siree! Right on one of the high points.

For if the minds which are responsible for the advertising pages of POWER, with all their facts and arguments and claims, have as their chief attributes the ability to evolve Snap and Catch and "Hot Air"—mere babblers of bright phrases—let the readers of the Ads. beware.

But if something else,—the story is very different.

Ever try to write an ad. for some product in the power field?

If you have, you've discovered that the very first thing to do, is to take off your coat, light your pipe and begin to plug away, *analyzing* the product that you're going to advertise.

Take it all to pieces—learn what it *really* is. Then tear it into finer shreds, pick out and analyze its exact points of superiority over all competing products.

Next begin the *analyzing* process all over again—from the other end. *Study* the needs of Power Plant Men. Pick *them* to pieces to see just how and where *your* product fits into those needs.

Then put your findings down in the simplest, most straightforward, briefest manner possible and you can be sure that you have a good ad.—one that will bring results.

And results not only for the man who is *selling* the product, but equally valuable results for the man who *ought* to have that product in his plant, but who has not known of its special merits.

Catch and Snap? Froth and Glitter? Again—*No*, siree!

Advertising genius is common horse sense in picking out what the purchasing public *wants* to know—and some aptitude and much training in presenting that meat in a nut shell.

Many concerns pay good men good salaries to spend all their time investigating the different kinds and makes of products which might be used in their plants, in order to get *just the* product best suited to their special needs. They employ their own specialists to *differentiate* and *analyze*.

That is just what the Advertising Minds back of POWER pages are constantly doing—digging out and presenting to the buyers, in its most easily digested form, everything worth knowing about the advertised articles.

The result—

The Advertising Section of each issue of POWER *is an epitome of Present Opportunities for most intelligently and wisely solving <u>your</u> particular problems of power plant equipment.*

Examine the ads. in *this* issue of POWER and see it for yourself. They're full of useful data—just the things you *need* to know.

The secret of successful advertising is Straight Stuff put up in Handy Packages.

And if *you* don't realize it, *you* are the chief loser!